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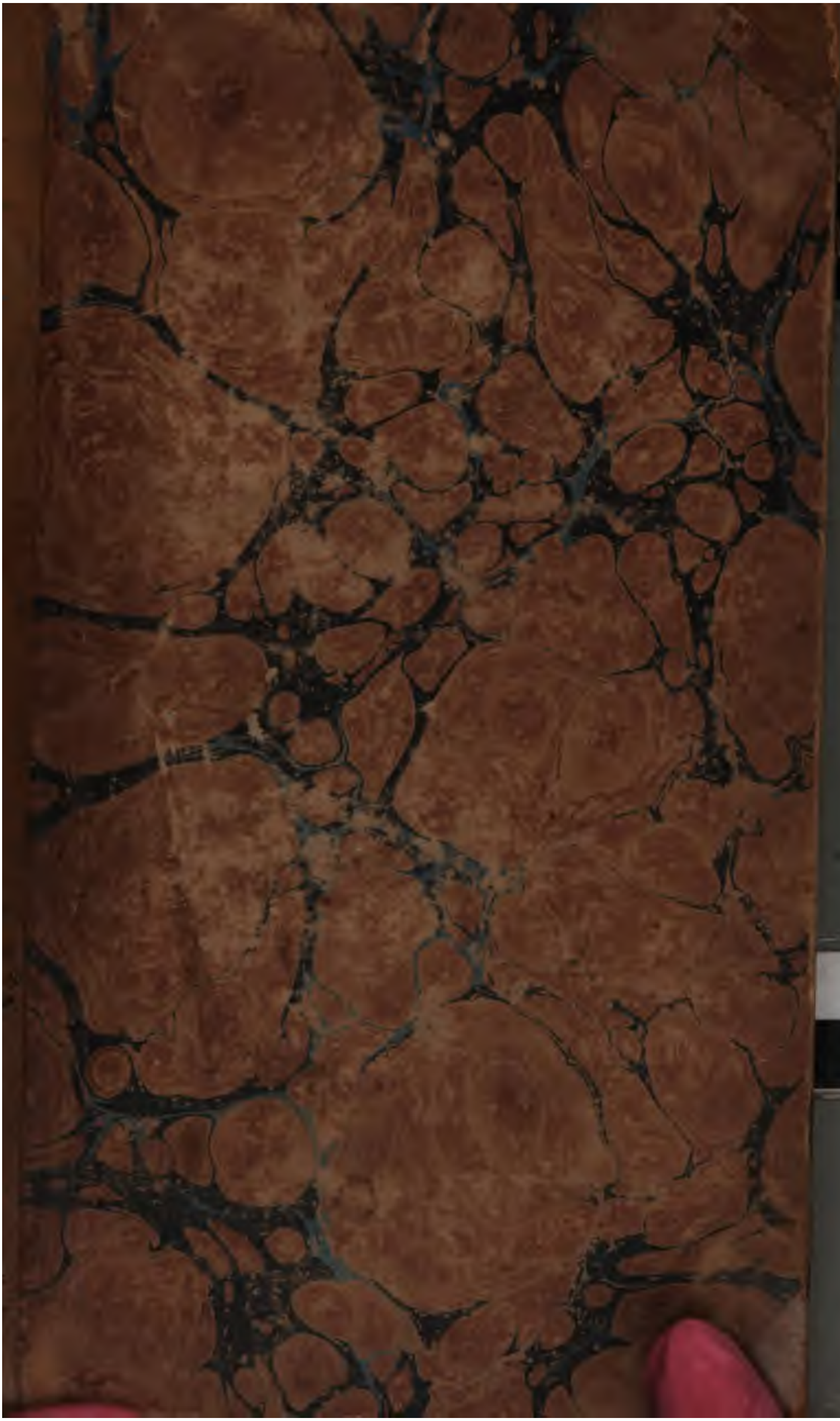

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INSTITUTIONS
OF
MEDICINE.

PART I.
PHYSIOLOGY.

For the uſe of the STUDENTS in the Univerſity of Edinburgh.

By WILLIAM CULLEN, M.D.
PROFESSOR OF THE PRACTICE OF PHYSIC, &c. &.

THE THIRD EDITION, CORRECTED.

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ADVEERTISMENT.

THE following ſheets were originally printed as a text-book for the uſe of Students of Medicine in the Univerſity of Edinburgh; it of courſe contains only ſketches of what was more fully delivered in the Profeſſor's lectures. Though the impreſſion formerly made has been long ago diſpoſed of, the Author did not chooſe to renew it till he ſhould be at leiſure to give it to the public in a more complete form. But Dr Gregory, who now teaches this branch of medicine, thinking thoſe ſketches might be uſeful to his Students, the author has conſented to the republication: and it is now offered to the public in a more correct manner.

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FIRST LINES

OF THE

PRACTICE OF PHYSIC.

By WILLIAM CULLEN, M.D.

Profeſſor of the Practice of Phyſic in the Univerſity of
Edinburgh; Firſt Phyſician to his Majeſty for Scotland;
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INSTITUTIONS
OF
MEDICINE.

I.

MEDICINE is the art of preventing and of curing diſeaſes.

II.

Before conſidering the application of this art to particular diſeaſes, certain general doctrines are neceſſary to be premiſed, which are called THE INSTITUTIONS OF MEDICINE.

III.

The Inſtitutions of Medicine are divided into three parts.

The firſt treats of life and health.

The ſecond delivers the general doctrine of diſeaſes.

The third delivers the general docctrine concerning the means of preventing and curing diſeaſes.

PART I.

PHYSIOLOGY.

IV.

THE doctrine which explains the conditions of the body and of the mind neceſſary to life and health, is called PHYSIOLOGY, or the Doctrine of the Animal Oeconomy.

V.

The functions of the animal œconomy are many and various; and ſo complicated with each other, that it is difficult to find the moſt proper order in which they may be delivered. That, however, ſeems the beſt which conſiders them as nearly as may be according to the ſeries of cauſes and effects.

VI.

Upon this plan we ſhall treat,

1. Of the ſolid matter, of which a great part of every organ of the body conſiſts.

2. Of the nervous ſyſtem, in which the motions of the body for the moſt part begin, and upon which the motions produced in it chiefly depend.

3. Of the motion and circulation of the blood, and of the ſeveral organs and actions employed in ſupporting it.

4. Of the functions employed in ſupporting and repairing the ſeveral ſolid and fluid matters of the body; and, on this occaſion, of the nature of the ſeveral fluids themſelves.

5. Of the organs employed in receiving and modifying the impreſſions of external bodies neceſſary to ſenſation; and of their ſeveral functions.

6. Of the motions of the whole body, or of its ſeveral parts which depend on the action of muſcles, and not before explained.

7. Of the functions peculiar to the ſexes, and of generation.

PHYSIOLOGY.

SECT. I.

OF THE SIMPLE SOLIDS.

VII.

THE ſolid parts of the body ſeem to be of two kinds; one whoſe properties are the ſame in the dead as in the living, and the ſame in the animate as in many inanimate bodies; the other, whoſe properties appear only in living bodies. In the laſt, a peculiar organization, or addition, is ſuppoſed to take place; in oppoſition to which, the firſt are called the SIMPLE SOLIDS. Of theſe only we ſhall treat here; and of the others, which may be called VITAL SOLIDS, being the fundamental part of the nervous ſyſtem, we ſhall treat under that title in the following ſection.

VIII.

The ſimple ſolids are ſuited to the purpoſes of the animal œconomy by a certain force of coheſion, joined with a certain degree of flexibility and elaſticity.

IX.

Theſe properties of the ſimple ſolids, in different parts of the body, in different bodies, and on different occaſions in the ſame body, are neceſſarily in different degrees; and this ſeems to depend upon the difference of the mixture, aggregation, or organization of the ſolid.

X.

The matter of the ſimple ſolid every

where, except in the bones, appears to be an homogeneous aggregate; and there is no proper evidence of its being formed of certain parts naturally diſcrete and incoherent, which are cemented by others of a different nature.

XI.

Of the ſimple ſolid conſidered as an homogeneous aggregate, the integrant parts are a mixt, which ſeems to be nearly of the ſame kind in all the different parts of the human body, and perhaps in moſt of the parts of every animal: So far as we yet know, the variety of it is very inconſiderable.

XII.

This, which may be called the ANIMAL MIXT, is found, by chemical experiment,

riment, to be conſiderably different from every kind of vegetable or foſſil matter; but the ſame experiments hardly teach us any thing exact or uſeful with reſpect to the conſtituent parts of this mixt.

XIII.

The only particular relative to this, which we exactly know, is, that the animal mixt is formed of water, and of ſome other matter concreting with it; that, on different occaſions, the ſtate of it is varied by the proportion which the water bears to the other concreting matter; and that, eſpecially by a different proportion in this reſpect, the ſimple ſolid differs in its force of coheſion, flexibility, and elaſticity (VIII.)

XIV.

The proportion of water to the other matter proportion of water in the ſimple ſolid, and thereby give a different ſtate of it, is ſufficiently obvious: That the ſame cauſes may alſo affect the other concreting matter, we can, in general, perceive to be poſſible; but in what manner, or upon what occaſions they do ſo, is not eaſily diſcerned.

XX.

The properties of the ſimple ſolid (VIII.) may be alſo varied by its ſtate of aggregation; and this again may be varied, 1. By the temperature of the atmoſphere to which the body is long expoſed. 2. By the preſſure, external or internal, which is applied to the ſolid. 3. By the degree of extenſion of the ſolid beyond its natural ſtate, which, in every living body, is given more or leſs to every part of the ſoft or flexible ſolids;

and, *laſtly*, by the motion or reſt to which the ſolid is accuſtomed.

XXI.

The properties (VIII.) of the ſolid parts are alſo varied by the ſtate of their organization. This every where depends upon an arrangement of fibres, the ſtate of cellular texture, or upon a texture of veſſels; and therefore, to explain the different ſtates of organization, it will be enough to mention the cauſes of the differences which occur in theſe fundamental parts.

XXII.

Fibres may differ in ſize by the ſeveral cauſes (XIV.—XXI.) affecting the mixture and aggregation of the matter of which they are formed, and by theſe cauſes alone; but how far the organization of any part depends upon an arrangement of fibres, we cannot diſtinctly perceive; and, if it does, we cannot perceive that the ſtate of ſuch parts differs otherwiſe than by the ſtate of the cellular texture every where interpoſed between the ſuppoſed fibres.

XXIII.

The ſtate of cellular texture is the moſt important circumſtance in all organized parts; and it may be varied by many different cauſes. 1. The texture may be more denſe, and thereby firmer, as it has been more preſſed by the actions of life or external force; by which means eſpecially it is changed in the progreſs of life. 2. The cellular texture may be increaſed in bulk, and rendered firmer by a new growth taking place in it, as frequently happens in membranes which are ſlowly and gradually ſtretched out. 3. The ſame texture may be-

become weaker by ſome part of it being eroded by acrid matters generated in the body, or externally applied. 4. It is analogous to this, that, when any part is ſuſtained by ſeveral layers of cellular texture or membranes, ſuch ſupport is weakened by one or more of theſe layers being cut through; and the ſame weakneſs is induced when any external compreſſion, which, for ſome time, had been applied, is taken away. 5. The ſtate of the cellular texture is varied by the matter contained in its cells; which is ſometimes a matter concreting into a ſolid maſs, and ſometimes a preternatural quantity of an aqueous inelaſtic fluid. The bones formed in the firſt manner may again become ſoft by the hardened matter's being diſſolved and reabſorbed. 6. When the mobility of parts on one another depends upon the extent of cellular texture connecting them, that mobility is diminiſhed or deſtroyed by a great part of the cellular texture being eroded or cut away, and the remaining parts being united together; ſo that the parts are now connected by a ſhorter portion of cellular texture than before. 7. Parts naturally ſeparate may loſe their mobility by being joined together by a cellular texture formed between them, as happens when any two ſurfaces are for ſome time kept cloſely applied to each other.

XXIV.

In ſo far as a ſolid part is formed by a texture of veſſels, its properties (VIII.) may be varied by the different ſtates of theſe veſſels; which, 1. may be more or leſs full of fluids. 2. They may be changed into a ſolid maſs, by the fluid, contained and ſtagnating in them, concreting into a ſolid. 3. They may be changed into a ſolid, if the fluids that ſhould paſs through them are intercepted, and the cavity is ſilled with a cellular texture; or, 4. They may be changed into a ſolid, if, by collapſe or preſſure, the ſides of the veſſels are applied to each other and concrete together.

XXV.

The pathology of the ſimple ſolids cannot be properly ſeparated from their phyſiology; and therefore many different ſtates of theſe ſolids, though ſuch as are always morbid are mentioned above. We think it proper to ſubjoin here a ſhort view of the whole of that pathology.

XXVI.

The diſeaſes of the ſimple ſolids are,

I. Thoſe of the naturally ſoft parts.

1. Debility with flexibility.

Debile tenerum, gracile, Gaub. Pathol. 161. 1.

Debile tabidum Gaub. ibid. 161. 2.

2. Debility with fragility.

Debile fiſſile Gaub. 161. 3.

3. Laxity.

Debile laxum, flaccidum, Gaub. 160. 1.

4. Flaccidity.

Debile iners Gaub. 160. 2.

5. Rigidity diminiſhing flexibility.

Rigidum tenax Gaub. 165. 1.

6. Rigidity deſtroying flexibility.

Rigidum durum Gaub. 165. 2.

II. Thoſe of the naturally hard parts.

1. Flexibility.

Debile flexile Gaub. 160. 3.

2. Fragility.

Fragile ſpongioſum Gaub. 161. 4.

Fragile vitreum Gaub. 165. 3.

Of all theſe morbid affections, we ſuppoſe the remote and proximate cauſes may be underſtood from what is delivered above (XIV.—XXIV.)

SECT.

SECT. II.

OF THE NERVOUS SYSTEM.

XXVII.

THE nervous ſyſtem, as the organ of ſenſe and motion, is connected with ſo ſo many functions of the animal œconomy, that the ſtudy of it muſt be of the utmoſt importance, and a fundamental part of the ſtudy of the whole œconomy.

A general view of the Nervous Syſtem.

XXVIII.

The nervous ſyſtem conſiſts of the medullary ſubſtance of the brain, cerebellum, medulla oblongata, and ſpinalis; and of the ſame ſubſtance continued into the nerves, by which it is diſtributed to many different parts of the body.

XXIX.

The whole of this ſyſtem ſeems to be properly diſtinguiſhed into theſe four parts.

1. The medullary ſubſtance contained in the cranium and vertebral cavity; the whole of which ſeems to conſiſt of diſtinct fibres, but without the ſeveral fibres being ſeparated from each other by any evident enveloping membranes.

N. When we ſpeak of functions, which are or may be in common to every part of this portion of the nervous ſyſtem, we ſhall ſpeak of the whole under the title of the BRAIN; but, when it is neceſſary to diſtinguiſh the particular parts, we ſhall take care to avoid ambiguity.

2. Connected with one part or other of N° 1. are, the NERVES, in which the ſame medullary ſubſtance is continued, but here more evidently divided into fibres, each of which is ſeparated from the others by an enveloping membrane derived from the pia mater.

3. Parts of the extremities of certain nerves (2.), in which the medullary ſubſtance is diveſted of the enveloping membranes from the pia mater, and ſo ſituated as to be expoſed to the action of certain external bodies, and perhaps ſo framed as to be affected by the action of certain bodies only: Theſe we name the SENTIENT EXTREMITIES of the nerves.

4. Certain extremities of the nerves (2.) ſo framed as to be capable of a peculiar contractility: and, in conſequence of their ſituation and attachments, to be, by their contraction, capable of moving moſt of the ſolid and fluid parts of the body. Theſe

we name the MOVING EXTREMITIES of the nerves: They are commonly named MOVING or USCULAR FIBRES.

N. That the muſcular fibres are a continuation of the medullary ſubſtance of the brain and nerves, has not been ſhown by the anatomiſts, nor univerſally admitted by the phyſiologiſts; but we now ſuppoſe it, and hope afterwards to render it ſufficiently probable.

Are the ganglions of the nerves to be conſidered as a part of the nervous ſyſtem diſtinguiſhed by a peculiar function?

XXX.

Theſe ſeveral parts of the nervous ſyſtem are every where the ſame continuous medullary ſubſtance which we ſuppoſe to be the vital ſolid of animals, ſo conſtituted in living animals, and in living ſyſtems only, as to admit of motions being readily propagated from any one part to every other part of the nervous ſyſtem, ſo long as the continuity and natural living ſtate of the medullary ſubſtance remains.

N. It is obſerved, that the compreſſion of any part of the medullary ſubſtance prevents the communication of motion between the parts that lie on different ſides of the part compreſſed; and it is probable, there are other cauſes beſides compreſſion, which may alſo affect the medullary ſubſtance, ſo as to interrupt in it the communication of motion; but they are not diſtictly known. In the mean time, we uſe the expreſſion, that a nerve, or other portion of the nervous ſyſtem, is *free*, to denote its being free, not only from compreſſion, but from every other ſuppoſed cauſe interrupting the communication of motion.

The condition fitting the medullary ſubſtance for having motion propagated in it, we ſuppoſe to be the preſence of a certain fluid; which we therefore name the *nervous fluid*, without meaning however at preſent to determine any thing with regard to its ſource, nature, or mannner of acting.

XXXI.

In the living man, there is an immaterial thinking ſubſtance, or MIND, conſtantly preſent; and every phenomenon of thinking is to be conſidered as an affection or faculty of the mind alone. But this immaterial and thinking part of man is ſo connected with the material and corporeal part of him, and particularly with the nervous ſyſtem, that motions excited in this give occaſion to thought; and thought, however occaſioned, gives occaſion to new motions in the nervous ſyſtem. This mutual communication or influence we aſſume with confidence as a fact: But the mode of it we do not underſtand, nor pretend to explain; and therefore are not bound to obviate the difficulties that attend any of the ſuppoſitions which have been made concerning it.

XXXII.

The phenomena of the nervous ſyſtem occur commonly in the following order. The impulſe of external bodies acts upon the ſentient extremities of the nerves; and this gives occaſion to preception or thought, which, as firſt ariſing in the mind, we term SENSATION. This ſenſation, according to its various modification, gives occaſion to VOLITION, or the willing of certain ends to be obtained by the motion of certain parts of the body; and this volition gives occaſion to the contraction of muſcular fibres, by which the motion of the part required is produced.

N. This is an example of the moſt ordinary caſe; but we do not mean to ſay it is the only caſe of communication between the different parts of the nervous ſyſtem.

XXXIII.

As the impulſe of bodies on the ſentient extremities of a nerve does not occaſion any ſenſation, unleſs the nerve between the ſentient extremity and the brain be free (XXIX. 3.); and as in like manner, volition does not produce any contraction of muſcles, unleſs the nerve between the brain and muſcle be alſo free; we conclude, from both theſe facts, that ſenſation and volition, ſo far as they are connected with corporeal motions, are functions of the brain alone; and we preſume, that ſenſation ariſes only in conſequence of external impulſe producing motion in the ſentient extremities of the nerves, and of that motion's being thence propagated along the nerves to the brain; and, in like manner, that the will operating in the brain only, by a motion begun there, and propagated along the nerves, produces the contraction of muſcles.

XXXIV.

From what is now ſaid, we perceive more diſtinctly the different functions of the ſeveral parts of the nervous ſyſtem, as diſtinguiſhed in (XXIX.), 1. The ſentient extremities (XXIX. 3.) ſeem to be particularly fitted to receive the impreſſions of external bodies; and, according to the difference of theſe impreſſions, and of the condition of the ſentient extremity itſelf, to propagate along the nerves motions of a determined kind, which, communicated to the brain, give occaſion to ſenſation. 2. The bain (XXIX. 1.) ſeems to be a part fitted for, and ſuſceptible of, thoſe motions with which ſenſation, and the whole conſequent operations of thought, are connected; and thereby is fitted to form a communication between the motions excited in the ſentient, and theſe in conſequence ariſing in the moving extremities of the nerves, which are often remote and diſtant from each other. 3. The moving extremities (XXIX. 4.) are ſo framed as to be capable of contraction, and of having this contraction excited by motion propagated from the brain, and communicated to the contractile fibre. 4. The nerves, more ſtrictly ſo called (XXIX. 2.), are to be conſidered as a collection of medullary fibres, each inveloped in its proper membrane, and thereby ſo ſeparated from every other, as hardly to admit of any communication of motion from any one to the others, and to admit only of motion along the continuous medullary ſubſtance of the ſame fibre, from its origin to the extremities, or contrariwiſe.

XXXV.

XXXV.

From this view of the parts of the nervous ſyſtem, of their ſeveral functions and communication with each other, it appears, that the beginning of motion in the animal œconomy is generally connected with ſenſation; and that the ultimate effects of ſuch motion are chiefly actions depending immediately upon the contraction of moving fibres, between which and the ſentient extremities the communication is by means of the brain. Wherefore, in ſtudying the nervous ſyſtem, we judge it proper to conſider, 1. Senſation, and with that the general function of the ſentient extremities. 2. The action of the moving fibres. 3. The function of the brain. In conſidering theſe three heads, the function of the nerves, more ſtrictly ſo called, will of courſe be ſufficiently explained.

CHAP. I.

OF SENSATION.

XXXVI.

OUR ſenſations may be be conſidered as of two kinds: 1. Thoſe which ariſe from the impulſe or impreſſion of external bodies, which we therefore name SENSATIONS OF IMPRESSION. 2. Thoſe which ariſe from the mind's being conſcious of its own action, and of the motions it excites; and theſe we name SENSATIONS OF CONSCIOUSNESS.

Senſations of Impreſſion.

XXXVII.

The ſenſations of impreſſion are very

various; but have been generally referred to five heads or kinds, commonly called the five ſenſes; that is, thoſe of ſight, hearing, ſmell, taſte, and touch.

XXXVIII.

The four firſt of theſe are each of them properly conſidered, as forming one genus of ſenſations: 1. As the particular ſenſations comprehended under each head (XXXVIII.), though very various, are, however, perceived to have ſomewhat common to all of them. 2. As thoſe of the ſame genus all ariſe from impreſſions made upon one part of the body only, and that of a peculiar organization. 3. As thoſe of the ſame genus all ariſe from the action of external bodies of one kind only, or of one and the ſame quality, by means of which they act upon our organs.

XXXIX.

No ſuch characters concur in eſtabliſhing one genus of the ſenſations referred to the fifth head of touch, which are various in all thoſe reſpects (XXXVIII.); and phyſiologiſts ſeem to have referred to this head of touch every ſenſation that does not manifeſtly belong to the other four, and among the reſt many of the ſenſations of conſciouſneſs. It might perhaps be uſeful to diſtinguiſh into genera, the ſeveral ſenſations referred to touch; but it is not neceſſary to be done here.

From certain ſenſations referred to touch, it appears, that not only the extremities (XXIX. 3.), but that every part of the nervous ſyſtem (XXVIII.), is ſentient with reſpect to certain impreſſions.

Senſations of Conſciouſneſs.

XL.

The ſenſations of conſciouſneſs may be referred to the following heads: 1. Thoſe of apperception, by which we are in general conſcious of thinking, of perceiving, judging, and willing, and thereby of our exiſtence and identity. 2. The ſenſations ariſing from the particular ſtate of thinking, as perception, memory, and judgment, are more or leſs clear, ready, or exact. 3. The ſenſations ariſing from the particular ſtate of volition, and its various modes. 4. The ſenſations ariſing from the general ſtate of action, as vigorous or weak, eaſy or difficult. 5. The ſenſations ariſing from particular actions, or a conſciouſneſs of the actions excited, and of the motion of the different parts of the body. 6. The ſenſations ariſing from the diminution or abſence of impreſſions.

Under each of theſe heads, a great number of particular ſenſations are comprehended, but not neceſſary to be farther ſpecified here.

Laws or general Circumſtances of Senſation.

XLI.

Of the four firſt genera (XXXVII.), the ſenſations ariſing give no indication of the nature of the bodies acting on our organs, or of the mode of their action; and when we otherwiſe learn theſe circumſtances, we can perceive no neceſſary connection between them and the ſenſations which they produce. But, from certain ſenſations of touch and conſciouſneſs, we acquire the notions of ſolid figure, of motion, impulſe,

pulſe, impenetrability, and the communication of motion, and conſider the ſenſations as exactly correſpondent to the circumſtances of external bodies. At the ſame time, as we know of no other action of bodies on each other but that of impulſe; and as, in the caſe of the ſenſations of the four firſt genera, we learn, that an impulſe takes place, we have comprehended the whole under the title of Senſations of Impreſſion, and conſider all of them as perceptions of impulſe.

XLII.

To produce any ſenſation of impreſſion, a certain force of impreſſion is neceſſary; and from a leſſer force, no ſenſation ariſes. The degree of force is likewiſe ſo limited on the other hand, that, in a high degree, it deſtroys the organ; and, in degrees approaching to this, a general ſenſation of pain, rather than the ſenſation of any particular object, is produced.

XLIII.

Within theſe limits, however, our ſenſations are not exactly correſpondent to the force of impreſſion, nor do they make any exact eſtimate of that force. Uſually ſenſation is relative to the change that is produced in the nervous ſyſtem; and a ſenſation proves ſtrong or weak, only as it is ſtronger or weaker than that which had immediately preceded it, or than that degree of force to which the nerves had been immediately before accuſtomed. For this reaſon too the limits (XLII.) are very variable.

XLIV.

Different ſenſations do not always imply a different kind of action in the bodies producing them; for ſometimes different ſenſations ariſe merely from a different degree of force in the ſame kind of action, as is manifeſt in the caſe of heat and cold.

XLV.

To ſenſation from impreſſion, a certain duration of impreſſion is neceſſary.

XLVI.

The mind's reſting for ſome time upon one ſenſation, is called ATTENTION. This, like the duration (XLV.), is neceſſary to give an impreſſion its full effect.

XLVII.

The mind ſeems to be determined to

attention by the force of impreſſion; by the pleaſure or pain ariſing from it; by the degree of emotion or paſſion produced by theſe; and, laſtly, by the emotion's being more or leſs related to the perſon feeling.

XLVIII.

If the force and duration of impreſſion, and the attention of mind, are all in the due degree, the ſenſation often remains for ſome time after the impreſſion or action of the external body has ceaſed.

XLIX.

The mind admits of, or can attend to, one ſenſation only at one time.

L.

Though the mind admits but of one ſenſation at one time, ſeveral impreſſions may act at the ſame time, if they be ſuch as can unite in producing a ſingle ſenſation; and ſuch is the caſe of many of the impreſſions which produce the particular ſenſations of the ſame genus, as in thoſe eſpecially of colour, ſound, ſmell, and taſte.

LI.

In each of theſe genera, many impreſſions, which ſeparately produce particular ſpecies, can unite in producing a ſingle ſenſation, which is always a neutral, or one different from either of the ſeparate ſenſations.

LII.

This union of impreſſions may take place, either when the impreſſions are exactly ſynchronous, or when the one ſucceeds the other before the ſenſation of the firſt (XLVIII.) has ceaſed.

LIII.

Though the motion excited in the ſentient extremities by impreſſion remains ſome time, as in (XLVIII.), it muſt be ſuppoſed to become continually weaker, till at length it ceaſes altogether, and with it the ſenſation.

LIV.

The ſame impreſſion ſoon repeated, does not produce the ſame ſtrength of ſenſation as before. Hence, all new impreſſions are, *cæteris paribus*, ſtrongeſt; and moderate impreſſions frequently repeated, produce no ſenſation, unleſs their force is conſiderably increaſed.

LV.

Actions which at firſt produced a ſenſation of conſciouſneſs, as accompanied with volition, come, by repetition, to be performed without any ſenſation; or they produce it only when they are performed with uneaſineſs, pain, or unuſual force.

LVI.

Impreſſions being given, their effects in producing ſenſation are different in different perſons, and in the ſame perſon at different times. This muſt ariſe from ſome difference in the ſtate of the bodies acted upon, which may perhaps be referred to the following heads: 1. The ſtate of the common teguments, or other parts interpoſed between the impreſſing body and the medullary ſubſtance of the ſentient extremity. 2. The different ſtate of the medullary ſubſtance of the ſentient extremities, as given to it in the original ſtamina. 3. The different ſtate of tenſion in the medullary ſubſtance of the ſentient extremities, as given to it by the ſtate of the blood-veſſels conſtantly connected with it. 4. The ſtate of the ſame medullary ſubſtance, as affected by heat or cold. 5. The ſtate of it as produced by former impreſſions (XLIII. LIV.) 6. The ſtate of the nerves along which the motion is propagated. 7. The ſtate of the brain or ſenſorium. 8. The ſtate of attention (XLVI. and XLVII.)

LVII.

Different parts of the body are ſenſible, and ſenſible only by means of nerves preſent in them: but anatomy does not always determine certainly with regard to the preſence or abſence of nerves; and, therefore, the ſenſibility of ſeveral parts can be determined by experiment only; which, however, is alſo fallacious.

LVIII.

Particular ſenſations ariſe from impreſſions on certain parts only: 1. Becauſe the ſentient extremities in theſe parts are ſo ſituated as to be expoſed to the action of certain external bodies only. 2. Becauſe the ſentient extremities are connected with an organ that increaſes the force of the external agent, or modifies its action in the manner neceſſary to a determined impreſſion. 3. Becauſe the fibres of certain ſentient extremities are, by their ſize or tenſion, fitted to be acted upon by certain external bodies only. 4. Becauſe certain ſentient extremities are ſo conſtantly preſerved in a certain ſtate, as to render them more ſenſible to a change.

Theſe circumſtances determine the mode of impulſe, but do not account for the ſenſation ariſing from it.

LIX.

Different ſenſations are accompanied with different judgements concerning the bodies making impreſſion, and the part of the human body upon which it is made. Some ſenſations are referred to bodies at a diſtance; others, to external bodies in contact; and others to the feeling body itſelf.

LX.

When ſenſations are referred to our own bodies, it is in three ſeveral ways: They are moſt commonly referred to the part on which immediately the impreſſion is made; and this, with regard to the external parts, very accurately; but, with regard to the internal, much leſs ſo: And commonly the ſenſations ariſing from internal parts, are referred to the incumbent external part, with ſome obſcure diſtinction between ſuperficial and more deep. 2. Senſations are ſometimes referred, not to the part upon which the impreſſion is immediately made; but to a diſtant more ſenſible part, to which a motion is propagated from the part impreſſed. 3. As ſenſations uſually ariſe from impreſſions made upon the extremities of the nerves, and are referred to theſe; ſo impreſſions made on the nerves in their courſe, are ſometimes referred to the extremities from whence they had commonly ariſen.

LXI.

The ſenſations of conſciouſneſs (XL. 1. 2.) are referred to the *encephalon*. So are thoſe of XL. 3. if they are moderate; but, if more vehement, they are often referred to thoſe parts in which their effects are exerted, as the heart and organs of reſpiration. The ſenſations (XL. 4. and 5.) are ſeldom, with accuracy, referred to particular parts, but indiſtinctly to a whole member. We are not conſcious of the action of particular muſcles, except when their contraction is ſpaſmodic.

LXII.

We are diſpoſed to combine our ſenſations as united in one object; and thus form what are called COMPLEX IDEAS.

LXIII.

We compare our ſeveral ſenſations, and from thence acquire new ſenſations of RELATION.

LXIV.

When ſenſations formerly received are again renewed by the ſame objects, it is, for the moſt part, with a conſciouſneſs of their having been formerly received; and this faculty we call REMINISCENCE.

LXV.

Perceptions formerly received can be renewed without the preſence or action of the object which formerly gave occaſion to them: and if this is attended with the conſciouſneſs of a difference between the vividity of the two perceptions, and particularly of the abſence of the original objects, ſuch a renewed perception is called an IDEA; and the faculty by which this renewal is made, is called MEMORY.

LXVI.

Perceptions formerly received, can, without the preſence of the original object, be renewed alſo in ſuch a manner, that the mind does not perceive any difference between the original and the renewed perception; and therefore, ſuch renewal is always attended with the perſuaſion of the preſence of the object. The faculty by which ſuch renewal is made, we call IMAGINATION, more ſtrictly.

LXVII.

Reminiſcence depends upon the force or frequent repetition of the former ſenſation.

LXVIII.

Memory depends upon an aſſociation of perceptions, which is formed by their being frequently repeated immediately after each other; by their being parts of the ſame complex idea; and, by their having relations marked. Memory is generally faithful to ſuch aſſociations: but it is more or leſs ſo in different perſons, according to the number and importance of the relations marked; according to the frequency of the repetition of the ſenſations, and the marking of their relations; and according them: and if this is attended with the conſciouſneſs of a difference between the vividity of the two perceptions, and particularly of the abſence of the original objects, ſuch a renewed perception is called an IDEA; and the faculty by which this renewal is made, is called MEMORY.

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LXIX.

Imagination ſeems always to depend upon internal cauſes, that is, upon cauſes acting in the brain.

LXX.

Memory and imagination renew diſtinctly the ideas of ſeeing and hearing only. All others are renewed imperfectly, or not at all; but all others may be aſſociated (LXVIII.) with the ſenſations or ideas of ſeeing and hearing, ſo that theſe become ſigns of the others. The memory, in renewing theſe ſigns, ſo far renews the idea belonging to them, as to renew their ſeveral aſſociations and relations; to renew, in ſome degree, the pleaſure or pain which formerly attended ed the ſenſations themſelves; and particularly to renew the emotions of mind, or motions of the body, which the ſenſations formerly produced.

LXXI.

Moſt of our ſenſations, perhaps all of them, are either pleaſant or painful.

LXXII.

The words *pleaſant* and *painful* are commonly generic terms, each of them comprehending a great many ſpecies, which ſeem to require being aſſorted under ſeveral different genera. Thus, in the firſt place, our ſenſations may be divided into thoſe we deſire, and thoſe we are averſe to. Of thoſe we deſire, we may diſtinguiſh thoſe which ariſe from qualities we refer to other bodies, from thoſe we refer entirely to our own. The firſt may be named more ſtrictly the AGREEABLE, the laſt the PLEASANT. In like manner, of the ſenſations we are averſe to, we may diſtinguiſh the DISAGREEABLE and the PAINFUL. But, farther, the laſt muſt be diſtinguiſhed from the ſenſe of averſion, which accompanies certain ſenſations of conſciouſneſs, as the ſenſe of debility, laſſitude, difficulty, &c. and particularly from that which is referred obſcurely to internal parts, and this we name ANXIETY. Theſe ſenſations may be called the UNEASY; and every one diſtinguiſhes this kind from that of the PAINFUL, more ſtrictly ſo called. Theſe laſt ſeem to be always ſenſations of impreſſion, referred pretty accurately to a particular part.

There is thus a foundation for eſtabliſhing different genera of the ſenſations we deſire, and of thoſe we are averſe to; as alſo, for greater preciſion in the employ-ment of terms: but the fixing the limits of theſe genera, and aſſorting the ſeveral ſpecies, may be ſtill difficult; ſo that we cannot be certain of applying the terms every where with ſtrict propriety.

LXXIII.

The enumeration of the agreeable or diſagreeable, and even of the pleaſant ſenſaſations, would not be of much uſe here; and the enumeration of the uneaſy and painful, though much more intereſting, belongs to the pathology. However, we think it proper to deliver here the few following propoſitions.

LXXIV.

Senſation and action, within certain limits, are always deſired; and the want of ſenſation, or imperfect and indiſtinct ſenſations, are always uneaſy. In action of every kind, the ſenſations of debility and difficulty are alſo uneaſy.

LXXV.

In ſenſations of impreſſion, their being pleaſant or painful often depends on the degree of force in the impreſſion, allowance being made for the ſenſibility of the ſyſtem.

LXXVI.

As impreſſions, by being repeated, produce weak ſenſations (LIV.), impreſſions, at firſt painful, may, by repetition, be changed into pleaſant, and the pleaſant into inſipid and uneaſy. Hence ariſes, with regard to moderate impreſſions, the pleaſure of novelty, the deſire of variety, and the deſire of increaſing the force of pleaſant impreſſions.

LXXVII.

There is a condition of impreſſions, rendering them objects of deſire or averſion, that cannot with certainty be referred to their force. This condition we call the quality of impreſſions.

LXXVIII.

Impreſſions are often rendered objects of deſire or averſion, by combination, ſucceſſion, and relation.

LXXIX.

No ſenſations ariſe originally in the mind, without a previous change in the ſtate of the body.

LXXX.

Certain impreſſions, and certain ſtates of the body, like to thoſe which produce the ſenſations of conſciouſneſs, may both of them act upon the nervous ſyſtem, without producing any ſenſation.

SECT. II.

CHAP. II.

OF THE ACTION OF MOVING FIBRES.

LXXXI.

THE moving fibres (XXIX. 4.), ſo far as yet known, are of one kind only, and the ſame every where, as in the moſt commonly known muſcles. Hence, the terms moving and muſcular fibres are of the ſame import.

LXXXII.

A muſcular fibre is ſuppoſed to have a peculiar organization, different both from that of the ſimple ſolid fibre, and from that of the medullary fibres in every other part of the nervous ſyſtem; but wherein that peculiarity of organization conſiſts, is not yet aſcertained.

LXXXIII.

A muſcular fibre is endued with a contractility, which is different from that of the ſimple ſolids, or of any inanimate elaſtics, eſpecially in this, that the contraction of a muſcular fibre is excited by cauſes which do not affect theſe others. For, the contraction of a muſcular fibre is excited by being extended; and a contraction is produced, whilſt the ſtretching power continues to be applied. The ſame contraction is alſo excited by various applications, whoſe mode of action we do not perceive; but we know them to be ſuch as do not affect inanimate elaſtics.

In reſpect of theſe cauſes by which it may be excited, the contractility of muſcular fibres hath been called IRRITABILITY.

LXXXIV.

The force of contraction in muſcular fibres is often much greater than that of the cauſes exciting it.

LXXXV.

The contractility of muſcular fibres (LXXXIII). appears eſpecially in living bodies, ceaſes with life, or ſoon after, and is probably never produced but with life. Hence it is, that, by ſome writers, it is called the VITAL POWER; and the muſcular fibre endued with it, the LIVING SOLID. *Gaub. Patholog.* 169, 170.

LXXXVI.

The contractility (LXXXIII. LXXXIV. and LXXXV.) hath been ſuppoſed to belong to muſcular fibres, independently of their connection with the other parts of the nervous ſyſtem; and, upon that ſuppoſition, it hath been called the *vis inſita*. We ſhall call it the INHERENT POWER; *Haller. Prim. lin.* 400.

LXXXVII.

The contraction of muſcular fibres can be excited by applications made to other parts of the nervous ſyſtem, as well as to the muſcles; and, as the effects of thoſe ap-

applications made to the other parts of the nervous ſyſtem can be prevented by ligatures made upon the nerves between the place of application and the muſcle to be moved, it is concluded, that the contraction of muſcular fibres can be excited by a power communicated to them by a motion propagated along the nerves. This power is called the NERVOUS POWER.

LXXXVIII.

The nervous power (LXXXVII.) is commonly determined to motion by the will. This we ſuppoſe to act in the brain only (XXXIII.), and to depend upon ſenſation, and other modifications of thought; and this power, which is to be chiefly referred to the mind, and acts in the brain only, we name the ANIMAL POWER.

LXXXIX.

The facility with which the contraction of muſcular fibres can be excited, and the force with which it can be performed, are to be diſtinguiſhed. The firſt we name the MOBILITY, the laſt the VIGOUR, of muſcular fibres. Both have been confounded under the name of Irritability.

XC.

The mobility and vigour of muſcular fibres (LXXXIX.) can both of them be increaſed or diminiſhed by various means. Whatever can excite the contraction of muſcular fibres is called a STIMULUS; and, in general, the means of exciting contraction are called STIMULANT POWERS. The means diminiſhing the mobility and vigour of muſcular fibres are called SEDATIVE POWERS.

XCI.

The inherent power (LXXXVI.) is ſuppoſed to be more vigorous, moveable, and permanent, in certain muſcular fibres than in others.

XCII.

The inherent power, or the contraction dependent upon it, can be excited by certain applications made either to the muſcles themſelves, or to the nerves connected with them; and, in either caſe, the effects of ſuch application are ſo exactly the ſame as to allow us to conclude, that the matter in the nerves, and in the muſcular fibres, is of the ſame kind.

XCIII.

The muſcular fibres are ſenſible to various impreſſions, and are otherwiſe organs of the ſenſations of conſciouſneſs (XL. 4. 5.) From this alſo, it is preſumed, that the muſcular fibres conſiſt of the ſame matter which is the ſubject of ſenſe in other parts of the nervous ſyſtem (XXXIX.)

XCIV.

From XCII. XCIII. and other conſiderations, we think it probable, that the muſcular fibres are a continuation of the medullary ſubſtance of the brain and nerves, as alleged XXIX.

XCV.

Though the muſcular fibres conſiſt of the ſame kind of matter as that in the nerves, the latter ſhow no contractility, becauſe they have not the peculiar organization (LXXXII.) of the former.

XCVI.

The nervous power (LXXXVII.), and the inherent (LXXXVI.), may ſubſiſt for ſome time without any connection of the nerves or muſcles with the brain; and they ſubſiſt alſo in entire bodies for ſome time after life has ſeemingly ceaſed. Both powers, however, are ſeemingly of equal duration in theſe reſpects; and neither power ſeems to ſubſiſt long but in entire and living bodies.

XCVII.

From what is ſaid (XCII.—XCVI.), it is probable, that the nervous and the inherent powers are ſomewhat of the ſame nature; and it is alſo probable, that, in entire and living bodies, both the nervous and inherent powers have a conſtant dependence upon the animal (LXXXVIII.)

XCVIII.

The contraction of muſcular fibres does not depend immediately on the motion of the blood, as it ſubſiſts in many animals after all motion of the blood has ceaſed.

XCIX.

The contraction of muſcular fibres does not depend on the inflation of veſicles, or other ſuch analogous ſtructure, as the ſhortening of the fibres in contraction is often greater than take place in ſuch ſtructure.

C.

As the force of coheſion in the muſcular fibres of living animals is much greater than in thoſe of dead ones, it is probable from this and other conſiderations, that the cauſe of muſcular contraction is an increaſe only of that ſame power which gives the contractility of the ſimple ſolids, and of other inanimate elaſtics; *Haller. Prim. Lin.* 407. 408.

If this is true, it will alſo explain why the force of coheſion in muſcular fibres is greater than that of the medullary fibres in any other part of the nervous ſyſtem, though both kinds of fibres (by XCIV.) conſiſt of the ſame kind of matter.

CI.

In living and healthy animals, the muſcular fibres have a conſtant tendency to contract; and this tendency we call their TONE, or TONIC POWER.

CII.

The tonic power of muſcular fibres neceſſarily

ceſſarily ſuppoſes their being conſtantly in a ſtate of extenſion beyond their natural or moſt contracted ſtate; and in this ſtate they are conſtantly kept by the action of antagoniſt muſcles, by the weight of the parts they ſuſtain, by fluids diſtending the cavities they ſurround, and by their connection with ſuch diſtended cavities, particularly the blood-veſſels.

CIII.

As the diſtention of muſcular fibres (by LXXXIII.) proves a ſtimulus (XC.), we conclude, that the tonic power in them will *cæteris paribus* be in proportion to the degree of tenſion (CII.)

CIV.

If the inherent power (as in XCVII.) is in dependenence upon the nervous and animal powers, and theſe may be increaſed or diminiſhed by various means, the tonic, as a part of the inherent power, muſt in ſome meaſure be in proportion to the ſtate of the nervous and animal powers.

CV.

If the tonic power of any muſcular fibre depends more upon its ſtate of tenſion (CIII.) than upon the ſtate of the nervous and animal powers (CIV.), ſuch fibres will be more affected by changes in the ſtate of tenſion, than by changes in the ſtate of the nervous and animal powers; and on the contrary, &c.

CVI.

The force of contraction, or the vigour of muſcular fibres, will be always as the force of ſtimulus, and the vigour of the animal, nervous, and inherent powers taken together.

CVII.

The mobility of muſcular fibres (LXXXIX.) ſeems often to be increaſed by cauſes which weaken their vigour; and, therefore, it is induced by the diminution of tenſion, and by cauſes weakening the animal, nervous, or inherent powers.

CVIII.

The ordinary contraction of muſcular fibres is diſpoſed ſpontaneouſly to alternate with a relaxation or extenſion of the ſame.

CIX.

In the ſtraight muſcles and in the heart, the alternate contractions and relaxations readly take place; and that though a ſtimulus is conſtantly applied: but in muſcular fibres ſurrounding cavities, as in the alimentary canal, bladder of urine, &c. the alternate motions do not appear, unleſs a portion of the fibres is cut out, and ſeparated from the reſt.

CX.

From a difference in the ſtate of a muſcle contracted by inherent power, while the member it ſuſtains is moved by external force, and that of the ſame muſcle contracted by the power of the will, we perceive that in the muſcles there may be a ſtate of relaxation without their extenſion.

CXI.

There is a ſtate of the contraction of muſcles that is not diſpoſed ſpontaneouſly to alternate with relaxation, and in which too the fibres do not eaſily yield to extending powers applied: Such a ſtate of contraction is called a SPASM.

CXII.

When muſcles are excited to contraction by preternatural caſes, and are contracted with unuſual velocity and force, and eſpecially when the contractions, alternating with relaxation, are frequently and preternaturally repeated; ſuch motions are called CONVULSIONS.

CXIII.

If the contraction of muſcles are exerted with unuſual force, and ſuch contractions are often repeated, they in a ſhort time become uneaſy and weaker; and though coutractions are not exerted with unuſual rorce, if they are often repeated, and for a long time, without an interval of reſt, they alſo become uneaſy and weaker.

CXIV.

Within certain bounds, with reſpect to force, frequency, and duration, the contraction of muſcles, by being repeated, is performed with more facility and force.

CXV.

Are not the contractions of muſcles produced by the action of the animal power; thoſe which are more eſpecially liable to become uneaſy and weak by frequent repetition?

SECT.

CXI.

There is a ſtate of the contraction of muſcles that is not diſpoſed ſpontaneouſly to alternate with relaxation, and in which too the fibres do not eaſily yield to extending powers applied: Such a ſtate of contraction is called a SPASM.

CXII.

When muſcles are excited to contraction by preternatural caſes, and are contracted with unuſual velocity and force, and eſpecially when the contractions, alternating with relaxation, are frequently and preternaturally repeated; ſuch motions are called CONVULSIONS.

CXIII.

If the contraction of muſcles are exerted ed with unuſual force, and ſuch contractions are often repeated, they in a ſhort time become uneaſy and weaker; and though coutractions are not exerted with unuſual rorce, if they are often repeated, and for a long time, without an interval of reſt, they alſo become uneaſy and weaker.

CXIV.

Within certain bounds, with reſpect to force, frequency, and duration, the contraction of muſcles, by being repeated, is performed with more facility and force.

CXV.

Are not the contractions of muſcles produced by the action of the animal power; thoſe which are more eſpecially liable to become uneaſy and weak by frequent repetition?

SECT. II.

CHAP. III.

OF THE FUNCTIONS OF THE BRAIN.

CXVI.

FROM the effects of ligatures made upon the nerves, and of the deſtruction of their continuity, it appears, that, in their entire ſtate, motions may be communicated from the brain to the other parts of the nervous ſyſtem, and from the latter to the former; and, from the ſame experiments it appears, that the brain (XXIX. 1.)

is the organ of ſenſation and volition, and of the ſeveral intellectual operations intervening between theſe: All which is confirmed by the effects of the organic affections of the brain upon the intellectual faculties.

CXVII.

The brain is thus the ſenſorium or corporeal organ, more immediately connected with the mind; and, ſo far as a corporeal organ is employed, all the operations of thought ariſing in conſequence of ſenſation are operations of the brain, and are modified by its various condition; *Boerh. Inſt. Med.* 581. *Haller, Prim. Lin.* 570. *Gaub. Path. Med.* 523. See afterwards (CXXII.)

CXVIII.

As certain impreſſions act on the nervous ſyſtem, without producing any ſenſation (LXXX.); and as, at the ſame time, there is hardly any communication between the different parts of the nervous ſyſtem, but by the intervention of the brain; it is from hence alſo probable, that the brain, by its organization, is fitted to propagate the motions ariſing in one part, to the other parts of the nervous ſyſtem; and, as theſe mechanical communications produce different effects, according to the different ſtate of the brain itſelf, we, upon the whole, conclude, that the brain is a corporeal organ ſuſceptible of various conditions, and thereby of conſiderable influence in moſt of the phenomena of the nervous ſyſtem.

CXIX.

The action of the brain, in moving the ſeveral parts of the body, is excited by various cauſes, or by the ſame cauſes in different circumſtances.

1. It is eſpecially excited by the WILL, directing the motion of certain parts as means to an end.

As the motion of certain parts is adapted to various purpoſes, we are conſcious of willing theſe purpoſes, as they occaſionally occur, and ſo far alſo of the motion of the parts concerned in them: but, where the motion of the parts is connected with one ſenſation, or a few only, the motions required follow theſe ſenſations without our being conſcious of ſpecially willing them; and, unleſs we have continued the practice of adapting the motions to different purpoſes, we loſe the power of doing ſo, and the motions become unavoidably connected with thoſe ſenſations which, for a long time, had alone given occaſion to them. In moſt of the inſtances of what are called VOLUN-

TARY MOTIONS, we are conſcious of willing the end propoſed, more than the motions excited; and, of the motions produced, we are conſcious chiefly of thoſe of a whole member, or of the general effect, and very little of the many particular motions that concur to produce it. We are never conſcious of the particular muſcles employed.

2. The action of the brain is excited by the more general and vehement volitions named EMOTIONS and PASSIONS. Upon occaſion of theſe, the conſciouſneſs of willing the particular motions produced is always much leſs diſtinct, and in many caſes is not at all perceived. Of the laſt kind are, particularly, moſt of the expreſſions of the paſſions in the countenance and geſture.

3. By the diſpoſition of human nature to IMITATION. This imitation is ſometimes involuntary, often without conſciouſneſs;

neſs; and the conſciouſneſs which takes place is often of the general purpoſe only, without that of the particular motions produced; or, at leaſt, it is of theſe only as a general effect.

4. By APPETITES or deſires, directed to certain external objects, and ariſing from ſenſation, without any reaſoning directing to an end; at leaſt, without any other end in the firſt inſtance but that of the gratification of the deſire.

5. By certain PROPENSITIES or deſires to remove an uneaſy or painful ſenſation, in conſequence of which motions are excited, which are not directed to any external object, but confined to the body itſelf.

Theſe motions are not foreſeen; nor are we ever conſcious of willing any thing, but the general effect. Of this kind, the chief are the motions of ſneezing, coughing, ſighing, hiccuping, vomiting, voiding urine and feces, yawning, ſtretching (*pandiculatio*), and thoſe motions of reſtleſſneſs and inquietude which pain and uneaſineſs produce. Weeping and laughing are expreſſions of emotion and paſſion.

In all theſe, as well as in the motions of N° 4. ſome volition is concerned, not only as they can often be prevented by another volition preſenting itſelf; but, beſides, as the ſeveral motions which occur in executing theſe propenſities are more or fewer, and more or leſs forcible, according to the vehemence of the propenſity or effort. Very often the ſtimulus to theſe propenſities is irreſiſtible; and, unleſs the peculiar ſtimulus is preſent, the motions cannot be produced by any volition.

6. By certain internal impreſſions ariſing from the exerciſe of the functions of the body itſelf, which produce no ſenſation, nor produce motions of which we are conſcious, except when exerciſed in an unuſual manner. Such are the cauſes of the mo-

tions of the heart and arteries, of the organs of reſpiration, of the ſtomach, inteſtines, and perhaps of many other parts. With regard to moſt of theſe motions, it may be ſuppoſed, that they are the mechanical effects of their ſeveral cauſes, acting upon the inherent power of muſcular fibres (LXXXVI.): but it is ſufficiently certain, that they alſo depend upon an action of the brain; and the effects of paſſions, as well as the effects of deſtroying or compreſſing the nerves of the organs concerned, are proofs of it.

The motions mentioned in this article are commonly ſuppoſed not to be accompanied with any volition of which we are diſtinctly conſcious. This perhaps is not ſtrictly true with regard to moſt of them; and, ſo far as it is, it may be imputed to that repetition which deſtroys conſciouſneſs (LV.): But neither can we entirely adopt this explanation; as theſe motions, which are intended to follow one ſtimulus only, may be ſuppoſed to require no exerciſe of volition, as in the caſe of the heart, arteries, and alimentary canal, while the action of reſpiration, as adapted to various purpoſes, continues to be a voluntary motion.

7. By various occaſional impreſſions of external bodies, and by various occaſional ſtates of the ſyſtem, or of its particular parts which excite motions, not only in the parts to which the impreſſions are immediately applied, but alſo in diſtant parts, on which they can operate only by the intervention of the brain. Some of theſe cauſes operate with, others without, ſenſation or volition.

CXX.

In all, or any of theſe caſes in which the action of the brain takes place, we do not perceive the manner, that is, the mechanical means, by which the ſeveral cauſes produce their effects; and we perceive only an inſtitution of our Maker, eſtabliſhing a connection between the ſeveral cauſes and the motions which enſue. At the ſame time we, for the moſt part, perceive, that the connections eſtabliſhed are ſuited to the purpoſe of the animal œconomy; and particularly, to the purpoſe of ſupporting the ſyſtem in a certain condition for a certain time, and of averting what might hurt or deſtroy it. This conſtitution of of the animal œconomy we call NATURE; and every where in the œconomy we perceive the *vires conſervatrices* and *medicatrices naturæ*, ſo juſtly celebrated in the ſchools of phyſic.

CXXI.

It is in conſequence of this conſtitution, that not only impulſe, and other cauſes which may be ſuppoſed to produce motion, do accordingly excite motions in the animal œconomy; but that alſo many cauſes which ſeem to diminiſh motion, do, however, produce an increaſe of motion in animal bodies. Thus ſeveral paſſions which, in their firſt tendency, diminiſh motion, ſeveral propenſities ariſing from debility and difficulty of action, the abſence of uſual impreſſions, evacuations, and other cauſes of relaxation, cold and narcotic powers, are all of them cauſes of conſiderable motions ariſing in the animal ſyſtem.

CXXII.

As the mechaniſm of the brain, ſuited to its ſeveral functions, is not at all perceived (CXX.); and, at the ſame time, as very few of theſe functions are carried on without ſenſation and volition, it muſt appear from this, and many other conſiderations, that the mechaniſm of the brain (CXVII.) would not be ſufficient for the purpoſe, without being united with a ſentient principle, or mind, that is conſtantly preſent in the living ſyſtem. But, at the ſame time, it is with little probability alleged, that the adminiſtration of the corporeal functions is entirely directed by the mind acting independently of the body, and with intelligence perceiving the tendency of impreſſions, and exciting ſuch motions as may favour the beneficial, or obviate the hurtful tendency of all cauſes acting upon the body.

We are certainly conſcious of no ſuch adminiſtration. Many impreſſions have their effects without ſenſation or volition. In moſt caſes where volition takes place, it is very general, with little conſciouſneſs of the motions excited, and none at all of the organs employed. The force of impreſſion is every where abſolute; and it is according to the force of impreſſion, and other mechanical conditions of the ſyſtem, that the motions excited prove either ſalutary or pernicious. The general principle, therefore, is ill-founded; it is not neceſſary, *(vide Stahl. Præf. ad Junker. Conſp. Med.)*; it can be of no uſe, and may be hurtful to the ſyſtem of phyſic.

CXXIII.

The action of the brain is often determined and regulated by cuſtom and habit; that is, by laws eſtabliſhed by frequent and uniform repetition. See above XLIII. LIV. LV. LVI. 5. LX. 3. LXVIII. and LXX. for the effects of cuſtom on ſenſation, and CXIV. for one effect of it on the action of moving fibres. It is now to be obſerved further, 1. That cuſtom determines the degree of tenſion (CII. CIII.) neceſſary to the action of muſcular fibres. 2. That cuſtom aſſociates motions with ſenſations, which are not otherwiſe their cauſes; ſo that the renewal of the ſenſation, or of its idea, renews alſo the motion. 3. That cuſtom aſſociates different motions, ſo that they cannot be ſeparately performed, tho' not originally, nor neceſſarily connected. 4. That cuſtom determines the degree of force and velocity with which motions can be performed. 5. That cuſtom determines the order of ſucceſſion in aſſociated motions, and the velocity with which they ſhall ſucceed one another. 6. That cuſtom eſtabliſhes the periodical return of certain ſenſations and motions, not originally neceſſary to the œconomy. 7. That cuſtom fixes an exact period for the return of certain ſenſations and motions, which, by the laws of the œconomy, are diſpoſed to return at intervals otherwiſe undetermined

mined. Theſe laws, which may be eſtabliſhed by cuſtom, are, many of them, with difficulty avoided; they are often rigidly fixed, have a conſiderable influence on the action of the brain, and govern the revolutions of the animal ſyſtem. Thus, any cauſes producing a deviation from the uſual degree of force and velocity (N° 4.) are apt to deſtroy the meaſure of it altogether; and, in like manner, cauſes producing a deviation from the uſual order and velocity in the ſucceſſion of motions (N° 5.) are apt to deſtroy the power of the mind in following that order, or in giving any meaſure to the ſeveral motions which ſhould be performed; and perhaps, in this way, the effects of debility, of ſeveral paſſions, and of ſurpriſe, are in ſome meaſure explained.

CXXIV.

The brain ſeems, by its conſtitution, to be diſpoſed to the alternate ſtates of reſt and activity; as appears in the alternate ſtates of ſleep and waking, which conſtantly take place in every animal: but wherein this conſtitution conſiſts, it is difficult to diſcover.

CXXV.

The moſt common opinion is, that the brain is a ſecretory organ, which ſecretes a fluid neceſſary to the functions of the nervous ſyſtem; that this fluid is alternately exhauſted and recruited, and thereby gives occaſion to the alternate ſtates of ſleep and waking. But this ſuppoſition is attended with many difficulties. 1. It is probable, that the nevous fluid exiſted in the animal embryo, before the action of the heart, or any ſecretory function, could take place. 2. In animals which during the winter ſuffer a temporary death, ſuch as bats, when by heat they are again reſtored to life, the vital power of the ſolids is reſtored before the fluidity of the blood. 3. The nervous fluid ſubſiſts in the nerves and muſcular fibres long after they are ſeparated from the brain, and often when cut into many ſmall parts. 4. Though it be true that the brain is a ſecretory organ, the fluid ſecreted may be deſtined to another purpoſe; and ſo far as we underſtand that purpoſe, the fluid fit for it, muſt be unfit for the purpoſe of ſenſe and motion. 5. There is no appearance, in any part of the nervous ſyſtem, of proviſion made for an occaſional accumulation of the ſecreted fluid; nor is there any evidence of its actually taking place. 6. The phenomena of ſleep and waking do not correſpond with ſuch a ſuppoſition; as ſleep often takes place when the ſecreted fluid muſt be copiouſly preſent, and waking can be protracted when the fluid is exhauſted much beyond its uſual meaſure. 7. Both ſtates are induced by many cauſes, which can hardly be ſuppoſed to act upon ſecretion.

CXXVI.

A certain compreſſion of the brain can produce a ſtate of the ſyſtem reſembling ſleep; but that ſtate is in ſome reſpects, different from that of ordinary ſleep: And it does not by any means appear, that natural and ordinary ſleep depends upon any compreſſion of the brain.

CXXVII.

As it is therefore probable that ſleep and waking do not depend upon a different quantity of the matter of the nervous fluid for the time preſent in the ſyſtem (CXXV.), or upon any cauſes interrupting its motion, while the condition of the matter remains the ſame (CXXVI.); we are diſpoſed to believe, that thoſe ſtates of ſleep and waking depend upon the nature of the nervous fluid itſelf capable of becoming more or leſs moveable; that it is chiefly in the brain ſuſceptible of theſe different conditions; and that, eſpecially by its condition there, it has its more general effects on the whole ſyſtem.

CXXVIII.

This may perhaps be confirmed by conſidering the remote cauſes of ſleep and waking: And it appears, that cold, the abſence of impreſſions, attention to a ſingle ſenſation, or to ſenſations that have no conſequence in thought or action; the finiſhed gratification of all vehement deſires, ſedative ſenſations and impreſſions, evacuations, relaxation, and any violent, frequent, or long continued exerciſe of the animal power; are all of them, ſeverally or together, cauſes inducing ſleep.

CXXIX.

On the other hand, it appears, that a certain degree of heat, all ſenſations of impreſſion, impreſſions analogous to thoſe which produce ſenſation, all ſenſations which lead to thought and action, and the increaſed impetus of the blood in the veſſels of the brain, are all of them cauſes favouring or inducing a ſtate of waking.

CXXX.

As moſt of the cauſes CXXVIII. are evidently ſuch as diminiſh motion in the brain,

brain, and thoſe of CXXIX. are ſuch as increaſe it; it is from thence probable, that the nervous fluid in the brain is truly capable of different ſtates or degrees of mobility, which we ſhall call its ſtates of EXCITEMENT and COLLAPSE; but, without intending, by theſe terms, to expreſs or determine any thing with regard to the nature of the nervous fluid, or wherein its different ſtates conſiſt.

CXXXI.

This ſubject may be further illuſtrated, by obſerving, that the excitement of the brain appears to be in very different degrees on different occaſions. It ſeems to be greateſt in certain maniacs endued with uncommon ſtrength, reſiſting the force of moſt impreſſions, and with the utmoſt difficulty admitting ſleep.

CXXXII.

A leſſer degree of excitement occurs in the ordinary ſtate of waking men in health, when the excitement is total with reſpect to the functions of the brain, but readily admitting of ſleep. This excitement may be conſidered as of two kinds; either as it reſpects the vigour, or as it reſpects the mobility of the ſyſtem: And theſe different ſtates of the brain are expreſſed in the body, by ſtrength or debility, alacrity or ſluggiſhneſs; and in the mind, by courage or timidity, gaiety or ſadneſs.

CXXXIII.

A degree of collapſe takes place in the caſe of natural ſleep, when the collapſe prevails ſo far as to ſuſpend very entirely the exerciſe of the animal functions; and, though the exerciſe of the vital and natural continue, they are conſiderably weakened. The partial collapſe that may take place in the brain diſcovers itſelf by the delirium which appears in a ſtate that often occurs as intermediate between ſleep and waking; and even in ſleep the collapſe with reſpect to the animal functions, takes place more leſs entirely; whence the ſleep is with or without dreaming, and the dreaming is more or leſs active.

CXXXIV.

A ſtill greater degree of collapſe takes place in the caſe of ſyncope; in which it is ſo great, as to ſuſpend the exerciſe of the vital functions concerned in the circulation of the blood, notwithſtanding the force of habit in theſe, and their being expoſed to conſtant ſtimuli. Here the collapſe may be very conſiderable; but there ſtill remains ſome degree of excitement

ment while the brain can be acted upon by ſtimuli, which act only on vital powers, and while its uſual excitement is ſtill recoverable by ſuch ſtimuli.

CXXXV.

If the collapſe is ſtill more complete and irrecoverable, it is the ſtate of DEATH.

CXXXVI.

From what is now ſaid of the excitement and collapſe of the brain, it will appear, that we ſuppoſe LIFE, ſo far as it is corporeal, to conſiſt in the excitement of the nervous ſyſtem, and eſpecially of the brain, which unites the different parts, and forms them into a whole. But, as certain other functions of the body are neceſſary to the ſupport of this excitement, we thence learn, that the cauſes of death may be of two kinds; one that acts directly on the nervous ſyſtem, deſtroying its excitement; and another that indirectly produces the ſame effect, by deſtroying the organs and functions neceſſary to its ſupport. Of the firſt kind are chiefly the cauſes of ſleep operating in a higher degree; as cold, ſedative paſſions, poiſons, and all cauſes of very violent excitement.

CXXXVII.

This ſubject may receive ſtill further illuſtration from conſidering the ſtate of the other parts of the nervous ſyſtem with reſpect to excitement and collapſe. In the nerves ſtrictly ſo called (XXIX. 2.), we do not know that the nervous fluid ſuffers any change, but what is exactly correſpondent to its ſtate in the brain and extremities;

and therefore the only difference of the ſtate of the nerves to be taken notice of is their being more or leſs free (XXX.)

CXXXVIII.

In the ſentient extremities of the nerves (XXIX. 3.), a difference of the ſtate of the nervous fluid ariſes from the ſeveral cauſes mentioned (LVI. 2. 3. 4. and 5.), which give a different degree of ſenſibility; and it is probable, that theſe different ſtates of the ſentient extremities are analogous to the different degrees of excitement in the brain.

CXXXIX.

The moving extremities, or muſcular fibres (XXIX. 4.), may alſo be in a different condition with reſpect to excitement. It is probable, that their conſtitution is ſuch as to admit of a higher degree of excitement than any other portion of the nervous ſyſtem; and that upon this their contractility depends. But, whatever is in this, we perceive very clearly, that the condition of muſcular fibres may be varied by cauſes affecting their tonic power (CI.), or their vigour and mobility (LXXXIX.), and by the effect of cuſtom (CXIV.); and it is probable, that the ſtates produced by theſe cauſes are analogous to the different degrees of excitement in the brain (CXXX.) and in the ſentient extremities (CXXXVIII); and thus the ſeveral parts of the nervous ſyſtem (XXIX.), as they conſiſt of the ſame kind of matter (XCIV.), are alſo ſubject to ſimilar conditions.

CXL.

The beginning of motion in the nervous ſyſtem is moſt commonly accompanied with ſenſation, and the force of this in producing its ſeveral effects is more or leſs, 1. According to the force (XLII.), quality (LXXVII.), and novelty (LIV.) of impreſſion. 2. According to the ſenſibility of the ſentient extremity and brain (LVI.) 3. According to the ſtate of attention (XLVII.) Theſe ſeveral cauſes often concur, frequently balance one another, and are always to be conſidered together.

CXLI.

The effect of ſenſation is commonly that of exciting the action of the brain; and this is generally according to the degree of volition produced under the different circumſtances mentioned in CXIX.

CXLII.

The action of the brain excited by volition or other cauſes, is determined to particular parts of the body, moſt conſtantly by the connections eſtabliſhed in the ſyſtem (CXX.), but alſo occaſionally, by acquired habits, or the greater mobility of certain parts.

CXLIII.

With regard to the connections eſtabliſhed in the ſyſtem (CXX. CXXI.) it is to be obſerved, as of great conſequence in pathology, that certain parts of the body which have a common function and conſtitution, have thereby a peculiar relation to the brain, ſo as to be more liable to be affected by the different ſtates of it, and in their turn by the difference of their condition to affect the brain. Such are, eſpecially, the organs of voluntary motion; the alimentary canal, and eſpecially the ſtomach; the circulatory ſyſtem, and particularly the extremities of the veſſels on the ſurface of the body; the uterine and genital ſyſtem in females; and ſome others to be mentioned in the pathology.

CXLIV.

The communications of motion between the ſeveral parts of the nervous ſyſtem which have been mentioned as inſtances of a particular ſympathy between theſe parts, are very ſeldom to be explained by any contiguity or contact, either in the origin or courſe of the nerves of the communicating parts; and more commonly they may be explained, by ſuppoſing the action of the impreſſion to be general with reſpect to the brain, and that the affection of particular parts depends upon the cauſes of determination (CXLII. CXLIII.)

When the action of ſeveral parts, together or ſucceſſively, are neceſſary to produce one effect, theſe concur, though the ſtimulus exciting the action of the brain is applied to one ſingle part only; and commonly no other cauſe of communication can be aſſigned, but the ſeveral motions being neceſſary to the execution of the volition, propenſity, &c. ariſing from the ſtimulus.

CXLV.

Theſe are the chief facts and laws relative to the nervous ſyſtem. The whole might perhaps be illuſtrated, and more exactly aſcertained, by a more particular inquiry into the nature of the nervous fluid; but we are not ſo confident in our opinion on this ſubject, or of the application it will admit of, as to deliver it here.

SECT. III.

OF THE CIRCULATION OF THE BLOOD.

CXLVI.

THE circulation of the blood, by CXXIX, ſeems neceſſary to the excitement of the brain; and for this, as well as other reaſons, it is, next after the function of the brain itſelf, the moſt important of the animal œconomy.

On this ſubject, we ſhall conſider, 1. The courſe of the blood. 2. The powers by which the blood is moved. 3. The laws and general circumſtances of the circulation. 4. Reſpiration as neceſſary to it.

On all theſe ſubjects we ſuppoſe the anatomy of the parts to be known.

SECT. III.

CHAP. I.

OF THE COURSE OF THE BLOOD.

CXLVII.

WOUNDS and hemorrhagies ſhow, that, in living bodies, the blood is in conſtant motion, and flowing into any one part from many others.

CXLVIII.

CXLVIII.

In man, and other analogous animals, which have once breathed for ſome time, the courſe of the blood is very conſtantly in the following manner.

From the left ventricle of the heart, the blood paſſes into the trunk of the aorta, and ſucceſſively into the following veſſels and cavities, viz. the branches of the aorta; the branches of the vena cava, the trunk of the ſame, the right auricle of the heart, the right ventricle of the ſame, the pulmonary artery, the pulmonary veins, the left auricle of the heart; from which laſt it paſſes into the left ventricle of the heart to return again into the ſame courſe as before.

From all this, it appears, that in the arteries the uſual courſe of the blood is from the heart towards the extreme branches of theſe; and that, in the veins, the courſe is in the contrary direction, from the extreme branches towards the heart.

CXLIX.

The courſe of the blood through the cavities of the heart, as above deſcribed, is not in a continued ſtream, but alternately interrupted and free during the contraction and dilatation of thoſe cavities, which alternately happen. Thus, while the left ventricle of the heart is in a ſtate of contraction, the blood paſſes out of it into the aorta; but at the ſame time no blood paſſes into it from the left auricle, which is then dilated and filled by the blood flowing into it from the pulmonary vein. It is only when the ventricle is emptied by contraction, and conſequently relaxed, that the blood paſſes into it from the auricle, urged by the contractions of the auricle and adjoining ſinus venoſus, which ſucceed immediately to that of the ventricle. During this contraction of the auricle and filling of the ventricle, no blood paſſes from the ventricle into the aorta, nor till a contraction of the ventricle ſucceeds in conſequence of its being filled. The ſame circumſtances take place with regard to the right ventricle and auricle of the heart, and preciſely at the ſame times; for it appears, that the two ventricles of the heart are contracted and relaxed at the ſame time; and, in like manner, the two auricles.

CL.

That the courſe of the blood, as deſcribed CXLVIII. and CXLIX. is its uſual and conſtant courſe, appears from inſpection of the heart in living animals; from the ſituation of the valves of the heart; from the ſituation of the valves at the orifices of the aorta and pulmonary artery; from the ſituation of the valves of the veins; from the effects of ligatures made upon the arteries and veins; from the effects of hæmorrhagies of the veins; from obſervations with the microſcope; and, laſtly, from experiments of infuſion and transfuſion in living, and of injection in dead animals.

CLI.

This courſe of the blood is, however, in ſome parts, and upon ſome occaſions, a little changed. 1. In the penis, and ſome other parts, the blood does not paſs from the extreme arteries immediately into continuous veins; but is poured out into an intermediate cellular texture, from which it is afterwards received by the extreme veins. 2. In the ſmall branches of the aorta, the blood does not move conſtantly in a direction from the heart towards the extremities; but, in certain portions of them, is ſometimes retrograde to that courſe. In this, it is favoured by the anaſtomoſes frequent between the ſmall veſſels, which, at the ſame time, prevent this deviation from being conſiderable or durable, while the action of the heart continues.

CLII.

In the courſe of the venous blood, there is alſo ſome variety. 1. In the ſmall veins, the blood is liable to have a motion retrograde to its uſual direction (CXLVIII.), as in the arteries (CLI. 2.) 2. The blood, returning to the heart from moſt parts of the body, paſſes ſucceſſively from ſmaller into larger veins, by a ſeries of pretty regularly increaſing veſſels, till they form the vena cava entering the heart. But this is varied in the abdomen, where the veins carrying the blood returning from every viſcus included in that cavity, except the kidneys and genitals, unite in forming the vena portarum, whereby they undergo a peculiar diſtribution. 3. The veins returning the blood from the extreme arteries in the brain, do not carry it to the heart by a ſeries of regularly increaſing veſſels, but by the interpoſition of ſinuſes, into which the ſmall veins iſſuing from the cortical part of the brain immediately pour their blood. 4. As the courſe of the blood through the veſſels of the lungs is not at all times equally free, and particularly is conſiderably interrupted at the end of exſpiration; ſo at the ſame time it is alſo interrupted at entering the right ventricle of the heart; and this often occaſions ſome regurgitation, or retrograde motion, in both the aſcending and deſcending cava.

CLIII.

The whole of the fluids carried in the aorta to its extreme branches, are not returned again by the continuous veins to the heart, as, by ſecretory veſſels, a part of them is conſtantly carried out of the courſe above deſcribed. Some of theſe ſecreted fluids are thrown entirely out of the body, and others are poured into certain cavities, for various purpoſes of the œconomy; and ſome of theſe are again returned into the courſe of the circulation. Of theſe laſt, there is a peculiar fluid which, from the extremities of the arteries, is poured out in a liquid form, or exhaled in that of vapour, into perhaps every cavity and vacuity of the body. This, after having ſerved the purpoſe of the effuſion, ſeems intended to be regularly returned again into the courſe of the circulation; and ac-

inherent power requires the conſtant ſupport of the nervous and animal powers, and is often actuated by theſe.

CLVII.

The contraction and relaxation of the heart, or, as theſe are called, its ſyſtole and diaſtole, are neceſſarily alternate by the general law (CVIII.) affecting all muſcles, and by the ſtimulus from the influx of venous blood being alternately applied and removed.

CLVIII.

If we may be allowed to eſtimate the vigour of muſcles by the number of their fibres, we muſt ſuppoſe the force of the heart to be very conſiderable; but it is very difficult to obtain any exact eſtimate of its abſolute force. It is perhaps the re-

lative force only that we are concerned to know.

CLIX.

Do the arteries, by their contraction, contribute to promote the motion of the blood begun by the heart? They cannot do it by the elaſticity of the ſimple ſolid in their ſtructure; and can do it only by their being endued with a muſcular power, whereby they may, in their contraction, communicate to the moving blood more than was loſt of the force of the heart in dilating them. That they are indued with a muſcular contractility (LXXXII.), is probable from the appearance of the muſcular fibres in their ſtructure; from their irritability appearing in the experiments of *Verſchuir;* from their becoming flaccid on tying the nerves belonging to them; from the motion of the

blood being ſupported, when the force of the heart is conſiderably weakened; from the motion of the blood becoming languid, when the action of the arteries is deſtroyed; from the velocity of the blood in the extreme arteries being greater than was to be expected from the velocity of the blood iſſuing out of the heart, expoſed to ſo many cauſes of retardation as conſtantly occur; and, laſtly, from the velocity and impetus of the blood in different parts of the body, and at different times, being unequal, while the action of the heart continues the ſame.

It is probable, that the muſcular fibres of the arteries become more irritable as the arteries are more diſtant from the heart.

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CLX.

The tone and action of the arteries, as a muſcular part, may be increaſed by ſtimuli immediately applied to them, or by the increaſed force of the nervous and animal powers with regard to them; and they may be diminiſhed by ſedative powers applied, or by weakening the nervous and animal powers.

CLXI.

There does not appear to be any oſcillatory motion in the extreme arteries independent of the action of the heart.

CLXII.

There does not appear to be any operation of capillary attraction in the extreme arteries; nor does there ſeem to be any occaſion for ſuch a power in any part of the arterial ſyſtem.

CLXIII.

The power of derivation (*Vis derivationis Ill. Halleri* 174.) in the ſanguiferous ſyſtem, ſeems to be no other than that which ariſes from the fulneſs of contractile veſſels.

CLXIV.

The motion of the blood in the arteries of any particular part is promoted by the action of adjoining muſcles.

CLXV.

The blood in the vena cava, and its branches, is moved by the action of the heart and of the arteries. Theſe powers are aſſiſted by the action of muſcles, which, in their contraction, preſs the veins lying between their ſeveral fibres; and alſo, by the ſwelling of their whole maſs, preſs the adjoining veins. Theſe veins are commonly provided with valves, which determine the effect of all preſſure upon them, to be the motion of the blood towards the heart.

The great trunks, both of the vena cava and pulmonary vein, are provided with muſcular fibres, and manifeſtly endued with muſcular contractility.

CLXVI.

In the abſorbent veſſels, the fluids are probably taken in by a capillary attraction.

CLXVII.

In the lymphatic veſſels, provided with numerous valves, which neceſſarily determine the motion of the contained fluid to be towards the heart, the fluid is moved by the preſſure of the neighbouring muſcles and arteries. But further, as the lymphatics are remarkably irritable, it is probable that the fluid in them is moved by a periſtaltic motion begun by the action of their abſorbent extremities.

CLXVIII.

The motion of the blood through the veſſels of the lungs, depends upon reſpiration, to be conſidered hereafter.

SECT. III.

CHAP. III.

OF THE LAWS OF THE CIRCULATION.

CLXIX.

THE velocity of the blood paſſing out of the left ventricle of the heart into the aorta, may be eſtimated from knowing the quantity of blood paſſing out at each ſyſtole, the area of the orifice of the aorta, and the time occupied by the ſyſtole; but none of theſe circumſtances are exactly aſcertained.

CLXX.

As the blood moves onwards through the arteries, the velocity (CLXIX.) ſuffers a conſiderable retardation from ſeveral cauſes. 1. From the capacity of the arteries being enlarged as they are more diſtant from the heart. 2. From the frequent flexures of the arteries. 3. From the angles which the branches make with the trunks from which they ariſe. 4. From anaſtomoſes. 5. From the viſcidity of the blood. 6. From the friction of adheſion. 7. From the weight and rigidity of the parts ſurrounding the arteries.

CLXXI.

The velocity (CLXIX.) and the cauſes of retardation (CLXX.) being given, the velocity of the blood in the arteries will be as the frequeney of the ſyſtole of the heart.

CLXXII.

The frequency of the ſyſtole of the heart will be more or leſs, 1. As the blood in the veins is more or leſs quickly returned to either ventricle of the heart. 2. As the ventricles of the heart are more or leſs entirely evacuated at each ſyſtole. 3. As the muſcular fibres of the heart are more or leſs moveable. 4. As the action of the nervous and animal powers are more or leſs increaſed with reſpect to the heart.

CLXXIII.

As the arteries of a healthy body are always full, the blood thrown out of the ventricles into the arteries during the ſyſtole of the heart, can only find a place there by puſhing on the blood with the velocity (CLXIX.), or by dilating the arteries; but as the reſiſtances CLXX. prevent the blood from flowing with the velocity CLXIX. the blood thrown out of the heart muſt, in ſome meaſure, dilate the arteries, and thereby form what is called the PULSE.

CLXXIV.

It appears, that, in the arteries to a certain length, the blood moves faſter during the ſyſtole than during the diaſtole of the heart; but as the reſiſtances and cauſes of retardation become greater in every portion of the arteries as it is more diſtant from the heart, ſo the acceleration of the blood during the ſyſtole of the heart muſt be greater in any portion of the arteries nearer the heart than in the next adjoining that is more diſtant; and ſo far as this takes place, a dilatation of the arteries will happen, even from a ſmall quantity of blood thrown out of the ventricles.

CLXXV.

As the reſiſtances to the blood's motion in the blood-veſſels increaſe with the diſtance from the heart, there may be a part of the ſanguiferous ſyſtem in which the motion of the blood will not be accelerated during the ſyſtole of the heart, and in which, therefore, no pulſe can be diſcerned. This happens in the extreme branches of the aorta; and no pulſe is ever obſerved in the extreme branches of the vena cava.

CLXXVI.

The velocity and impetus of the blood

in the whole ſyſtem of blood-veſſels will always be as the action of the heart and arteries taken together.

CLXXVII.

The velocity and impetus of the blood, in any particular part of the ſyſtem, will be, 1. As the part is more or leſs diſtant from the heart. 2. As the circumſtances (CLXX.) take place more or leſs in the part. 3. As the gravity of the blood concurs with, or oppoſes its motion in the part. 4. As cauſes increaſing or diminiſhing the action of the arteries of the part are applied or removed.

CLXXVIII.

The quantity of blood diſtributed to any particular part of the ſanguiferous ſyſtem, will be greater or leſs according to the velocity and impetus of the blood in the part, by CLXXVII.; and according to the reſiſtances in other parts being increaſed or diminiſhed by conſtriction, compreſſion, ligature, poſition, relaxation, or aperture.

CLXXIX.

The flexibility and contractility of the blood-veſſels render the effects of all increaſe or diminution of reſiſtance in any particular part moſt conſiderable in the neareſt, and very little ſo in the more remote, veſſels of the ſyſtem. By this we are to judge of the celebrated doctrines of derivation and revulſion.

CLXXX.

The quantity of blood diſtributed to the different parts of the ſyſtem, is in different proportion at different periods of life.

1. The capacity and force of the heart, in proportion to the ſyſtem of veſſels, is greater at the beginning of life than at any after period. Till the body arrives at its full growth, the capacity of the veſſels increaſes in greater proportion than that of the heart; but from that period, the capacity of the veſſels is conſtantly diminiſhing, while that of the heart ſuffers little change.

2. A greater quantity of blood is contained in the arteries, in proportion to that which is contained in the veins, at the beginning of life, than at any after period. From the time that the body has arrived at its full growth, the quantity of blood contained in the veins, in proportion to that which is contained in the arteries, is conſtantly increaſing.

3. The veſſels of the head receive a

greater quantity of blood, in proportion to the reſt of the ſyſtem, at the beginning of life than at any after period.

4. Any general increaſe of the action of the heart and arteries determines the blood more copiouſly to the extreme arteries on the ſurface of the body, than to thoſe of the internal parts.

5. The equilibrium of the ſanguiferous ſyſtem, with regard to the diſtribution of the blood, may be changed by various cauſes (CLXXVII. CLXXVIII.); and theſe cauſes continuing to operate for ſome time, induce a habit which renders the changed diſtribution neceſſary to the health of the ſyſtem.

6. The lymphatic ſyſtem is fuller in young perſons than in old.

SECT. III.

CHAP. IV.

OF RESPIRATION.

CLXXXI.

RESPIRATION conſiſts of the motion of inſpiration, or the admiſſion of air into the lungs; and of exſpiration, or the expulſion of air from the ſame; alternately happening.

CLXXXII.

Reſpiration takes place in man, and

other analogous animals, ſoon after the infant is taken from the uterus of the mother, and is expoſed to the air. After it has taken place for a little time, it is ever after neceſſary to the continuance of life, as it is abſolutely neceſſary to the continuance of the circulation of the blood.

CLXXXIII.

The lungs are a hollow ſpongy maſs, capable of confining air, and readily dilatable by it. By the wind-pipe, they are open to the atmoſphere; and they are ſo ſituated in the thorax, that the air muſt enter into them, if the cavities of the thorax, in which they are placed, are enlarged. For, as there is no air in theſe cavities, and the external air cannot enter into them, the enlargement of the thorax muſt form a vacuum around the lungs, which the external heavy and elaſtic air will ſupply by entering into and dilating the lungs, while theſe do not allow the air to paſs through them into the cavities of the thorax.

CLXXXIV.

Inſpiration therefore depends upon the enlargement of the capacity of the thorax; and this is performed chiefly by the contraction of the diaphragm. This in its relaxed ſtate is ſuſpended by the mediaſtinum, and its middle tendinous part is raiſed high in the thorax; wherefore, as this middle part, by the contraction of the muſcular, is moved downwards, the thorax is thereby conſiderably enlarged.

CLXXXV.

The capacity of the thorax is alſo enlarged by the motion of the ribs upwards, whereby the curvatures of oppoſite ribs are ſet at a greater diſtance from each other; and, by the ſame motion, the ſternum is moved outwards, and ſet at a greater diſtance from the vertebræ of the back. The motion of the ribs upwards is cauſed by the contraction of both layers of intercoſtal muſcles. That the muſcles called internal intercoſtals concur with the external in raiſing the ribs, appears from the ſituation of thoſe muſcles, from the greater mobility of the inferior ribs, from the inſpection of thoſe muſcles in living animals, and from experiments imitating their action. In more violent and laborious inſpirations, the raiſing of the ribs is aſſiſted by many muſcles attached to the ribs, and ariſing from the clavicle, humerus, ſcapula, and vertebræ of the neck or back.

CLXXXVI.

By the enlargement of the thorax, a dilatation of the lungs is produced, in proportion to the bulk of air entering into them; but the dilatation may often be greater by the air that enters into the lungs being heated and rarified; and the greateſt diſtenſion of the lungs is obtained by a conſtriction of the glottis confining the air that has already entered into the lungs.

CLXXXVII.

As inſpiration, or the admiſſion of air into the lungs, depends upon the enlargement of the thorax, the diminution of it muſt expel the air, or produce exſpiration. The capacity of the thorax is diminiſhed, while the muſcles dilating it are ſpontaneouſly relaxed, by the elaſticity of the ligaments connecting the ribs with the vertebræ, and by the elaſticity of the cartilages and ligaments connecting the ribs with the ſternum; both which powers, commonly aſſiſted by the weight of the ribs themſelves, bring the ribs and ſternum into the poſition they were in before inſpiration. At the ſame time, the elaſticity of the mediaſtinum draws the diaphragm upwards; and the contraction of the abdominal muſcles both preſſes the diaphragm upwards, and pulls the ribs downwards; and, in the laſt, they are aſſiſted by the ſterno-coſtal and infra-coſtal muſcles. While theſe powers concur in diminiſhing the capacity of the thorax, the expulſion of the air from the lungs is aſſiſted by the elaſticity of the lungs themſelves, and by the contraction of the muſcular fibres of the bronchiæ.

CLXXXVIII.

Theſe are the ordinary powers of exſpiration, which, depending upon the reaction of elaſtic parts, is performed ſlowly, and with little force; but when it is neceſſary to perform it with more velocity and force, ſome other and very powerful muſcles, as the quadratus lumborum, ſacrolumbalis, and longiſſimus dorſi, concur in pulling down the ribs; and, at the ſame time, the abdominal muſcles, actuated by the animal power, are contracted with greater velocity and force than in ſpontaneous exſpiration.

CLXXXIX.

The ſituation of the blood-veſſels of the lungs is ſuch, that, in the contracted ſtate of this viſcus, theſe veſſels muſt be much folded and ſtraitened; and it appears, that, in the fœtus, where they are conſtantly in a contracted ſtate, their capacity is not ſufficient to tranſmit, in the time required, the whole of the blood returning to the heart by the vena cava; but, after reſpiration has been repeated for ſome time by the dilatation of the lungs to a certain degree in inſpiration, their blood-veſſels are unfolded, lengthened, and enlarged, ſo as to be capable of tranſmitting the whole blood of the cava.

§ CXC.

In the infant who has breathed for ſome time, the whole blood of the vena cava paſſes into the right ventricle of the heart, and from thence enters into the veſſels of the lungs; but, in the contracted ſtate of the lungs which occurs at the end of exſpiration, the blood cannot be properly tranſmitted; and, for that purpoſe, an inſpiration becomes abſolutely neceſſary.

CXCI.

It is, however, under a certain degree of inſpiration only, that the blood is freely tranſmitted through the veſſels of the lungs; for, if the inſpiration is full, and continued, ſo that the lungs are thereby much diſtended, we find that this ſtate alſo interrupts the free paſſage of the blood, and renders exſpiration neceſſary.

Exſpiration becomes alſo neceſſary; becauſe, perhaps, the air long retained in the lungs loſes a part of its elaſticity, and becomes thereby unfit to keep the lungs diſtended; but, more certainly, and more eſpecially, becauſe, in an animal that has breathed for ſome time, there is a noxious vapour conſtantly ariſing from the lungs, which, if not diſſolved by the air, and carried out of the lungs, proves pernicious to life.

CXCII.

From what has been ſaid, it appears, that the alternate motions of inſpiration and exſpiration are neceſſary to the circulation of the blood, and otherwiſe alſo to the health of the body; and it appears alſo, that the more frequent the alternate motions of reſpiration are, the more quickly is the blood tranſmitted from the right to the left ventricle of the heart.

CXCIII.

We can now perceive alſo the cauſes exciting theſe alternate motions; and we find no occaſion for ſuppoſing them to ariſe from any cauſes alternately interrupting the motions of the nervous fluid, or of the blood, into the muſcles concerned in theſe functions.

Inſpiration, or the action of the muſcles producing it, is excited, in all caſes of general effort, to remove pain and uneaſineſs; and it is, perhaps, a propenſity of this kind that gives the firſt beginning to reſpiration in the new-born infant, exposed to ſeveral new and uneaſy impreſſions.

For the continuance of reſpiration, inſpiration is eſpecially excited by the ſenſe of uneaſineſs that attends any difficulty in the paſſage of the blood through the veſſels of the lungs; but this uneaſineſs ariſes, in ſome meaſure, at the end of every exſpiration, and is much increaſed by any continuance of this ſtate.

CXCIV.

Exſpiration, in ſome meaſure, neceſſarily ſucceeds inſpiration, by the ſpontaneous relaxation of the inſpiratory muſcles (CVIII.), while the elaſticity of the membranes, ligaments, and cartilages ſtretched in inſpiration, brings back the ribs and diaphragm into their former ſituations; and the ſame effects are alſo produced by the action of the abdominal muſcles, and of the muſcular fibres of the bronchia; both of which are ſtretched, and thereby excited in inſpiration.

In the caſe of ordinary inſpiration, theſe cauſes are ſufficient to produce a ſpontaneous exſpiration. But as it appears that a violent and long continued inſpiration interrupts the paſſage of the blood through the lungs, this creates an uneaſineſs, and a propenſity, which muſt produce a relaxation of the inſpiratory, and excite a contraction of the exſpiratory, muſcles.

It is further to be ſuppoſed, that, in animals which have breathed for ſome time, cuſtom has aſſociated the ſeveral motions concerned both in inſpiration and exſpiration; ſo that an irritation applied to any part of them neceſſarily excites the whole; and it may alſo be ſuppoſed, that habit determines theſe motions regularly to ſucceed one another.

CXCV.

In this manner (CXCIII. CXCIV.) reſpiration is continued for the general purpoſes of the animal œconomy; but the ſeveral motions of which it conſiſts are alſo occaſionally excited and variouſly modified by the will, intending particular effects to be produced by theſe motions. They are alſo excited, and variouſly modified, by certain emotions and paſſions, and give particular expreſſions of theſe. They are often excited alſo by imitations; and they are particularly excited by propenſities to remove pain and uneaſineſs, which operate more frequently on reſpiration than upon any other function.

CXCVI.

The conſideration of the effects of reſpiration on the animal fluids is delayed till the nature of theſe fluids ſhall have been more generally conſidered.

SECT. IV.

OF THE NATURAL FUNCTIONS.

CXCVII.

THE animal body from a ſmall beginning, grows to a conſiderable ſize; and at the ſame time, from the period of the birth, during the whole of after life, the body ſuffers, by various means, a daily and conſiderable waſte.

CXCVIII.

The increaſe of bulk, therefore, muſt be acquired, and the daily waſte ſupplied, by matters taken into the body, the moſt part of which, from the preſumed purpoſe of them, we name ALIMENTS.

CXCIX.

A great part of theſe aliments, as taken into the body, are of a different nature from the matter of the body itſelf; or at leaſt, are in ſuch a ſtate as not to be fit for being immediately applied to the purpoſes of it: they muſt, therefore, be changed, and fitted to the purpoſes of the œconomy, by powers within the body itſelf.

CC.

The converſion, or aſſimilation, of the aliments to the nature of the ſolids and fluids of the animal body; the farther changes of theſe fluids for various purpoſes, by ſecretion; and the application of ſome part of them in nutrition, or in increaſing the growth of the body; make what are called the NATURAL FUNCTIONS.

SECT. IV.

CHAP. I.

OF DIGESTION.

CCI.

THE term *digeſtion* is commonly employed to ſignify the function of the ſtomach alone in changing the aliments; but, in this chapter, we are to conſider all the changes of theſe as they occur ſucceſſively in the different ſtages through which the matters paſs.

CCII.

Animals are determined to take in aliment, by the appetites of hunger and thirſt.

CCIII.

Hunger is an appetite depending upon a ſenſation referred to the ſtomach, and ariſing from a particular ſtate of it.

This ſtate ſeems to be in ſome reſpect the degree of emptineſs, but more eſpecially the ſtate of contraction in the muſcular fibres which emptineſs gives occaſion to. This ſtate of contraction may alſo be excited by certain ſtimulants applied; but more commonly it depends upon, and is correſpondent to, the ſtate of inanition, and therefore of contraction, in the veſſels of the ſkin emitting the matter of perſpiration.

CCIV.

Thirſt is an appetite for liquids, which depends upon a ſenſation chiefly referred to the internal fauces, and ariſing from the dryneſs or heat of theſe parts; from acrimony applied to them, or exiſting in the fluids poured out there; from the putreſcency or viſcidity of the contents of the ſtomach; and from all increaſed evacuations.

CCV.

Theſe appetites determine men to take in a great variety of ſolid and liquid matters, directed by inſtinctive likings and diſguſts; in ſome inſtances corrected by experience.

CCVI.

Of the matters choſen, it appears that ſome of them are ſuited to ſupply the matters of the fluids or ſolids of the body, and therefore properly named Aliment; while others of them are ſuited only to improve the reliſh of aliment, or to obviate ſome deviations ready to happen in the buſineſs of digeſtion; and theſe we name CONDIMENTS.

CCVII.

The proper alimentary matters are animal or vegetable only.

CCVIII.

The animal aliments ſeem to be ſo nearly of the ſame nature with the matter of the body itſelf, that, to be rendered fit for the purpoſes of the œconomy, they ſeem to require no other change but that of being rendered fluid.

CCIX.

But the vegetable aliment is very different from the matter of the animal fluids or ſolids, and muſt therefore be changed into the nature of theſe by the powers CXCIX; and as many animals are nouriſhed by vegetable aliment alone, and as perhaps all animal matters may be ultimately traced to a vegetable origin, it will appear, that, to account for the production of animal matters, it is eſpecially, and in the firſt place, neceſſary to ſhow how vegetable matter may be converted into animal.

CCX.

If we conſider the many different odours, taſtes, and colours, which are to be obſerved in different vegetables, we ſhould be ready to think that vegetable matter is of very great variety: but we know that the matter diſtinguiſhed by its ſenſible qualities makes but a ſmall part of the whole of any vegetable; and that, beſides the matter peculiar to each, there is in moſt, perhaps in all vegetables, a large proportion of common matter, which we preſume to be the matter adapted, and that very univerſally, to the aliment of animals.

CCXI.

It is this common matter of vegetables, therefore, that we are to conſider here;

when blended with oily matter in dif-
proportion, that makes the greateſt
of the common matter of vegetables,
is the chief part of the vegetable
ent of animals. It is this, therefore,
we have eſpecially to conſider here;
as it lies in vegetables, it is different
n the moſt part of animal matters in
following reſpects.

is readily ſuſceptible of a vinous and
ous fermentation, and ſpontaneouſly
ers into the one or the other of theſe;
, without undergoing more or leſs of
ſe, it perhaps never enters into a putre-
tive fermentation.

The ſame matter treated by diſtillation,
ithout addition, gives out always, in the
rſt part of the diſtillation, an acid, and
nly afterwards a volatile alkali in ſmall
proportion.

The ſame vegetable matter, treated by calcination, leaves aſhes, which contain a fixed alkali, and an earth that is or may be converted into a quick-lime.

CCXIV.

In all theſe reſpects, the common matter of animals is conſiderably different.

This enters ſpontaneouſly into a putrefactive fermentation, and that without paſſing through the vinous or acetous: At leaſt, theſe are not to be diſtinctly perceived.

The ſame animal matter, treated by diſtillation, gives out always, in the firſt part of the diſtillation, a volatile alkali in large proportion, and only afterwards by a great force of fire it gives out an acid.

Animal matters, treated by calcination, leave aſhes, in which no alkali is to be found; and the earth is not calcareous, nor convertible into a quick-lime, by any means yet known.

CCXV.

Theſe differences are ſufficiently marked; but it is proper to obſerve here, that the vegetable matter we treat of, by undergoing a putrefactive fermentation, is changed ſo, as to acquire very exactly moſt of thoſe characters of animal matter we have juſt now mentioned.

CCXVI.

The aliment being thus conſidered, we proceed to conſider the changes it undergoes after being taken into the animal body; but, firſt, of the courſe it paſſes through, and of the motions it is ſubjected to in its progreſs.

CCXVII.

The aliment is taken into the mouth; and there the more ſolid parts of it are commonly ſubjected to a triture, or what is called manducation. At the ſame time a quantity of ſaliva, and of the other fluids of the mouth, with ſome portion of our drink, is intimately mixed with it, whereby the whole is reduced to a ſoft pulpy maſs. In this ſtate, by the action of deglutition, it paſſes through the fauces into the œſophagus, by which it is conveyed into the ſtomach.

CCXVIII.

Here the aliment is detained for ſome time, ſubjected to a conſtant agitation and ſome preſſure, both by the contractions of the different parts of the ſtomach itſelf,

ſelf, and by the alternate preſſure of the diaphragm and abdominal muſcles. After ſome time, however, firſt the more fluid parts, and at length the moſt minute parts of the ſolid matter are puſhed thro' the pylorus into the duodenum.

CCXIX.

The matters received from the ſtomach into the duodenum paſs on from thence ſucceſſively through the ſeveral parts of the inteſtinal canal; and, in the whole of the courſe, the matters are ſtill ſubjected to the alternate preſſure of the diaphragm and abdominal muſcles, and to the contractions of the inteſtines themſelves.

CCXX.

Through the whole courſe of the inteſtines, but eſpecially in thoſe named *the* *ſmall*, the more fluid part of the contents, and particularly the peculiar fluid we name *chyle*, is taken into the veſſels named *lacteals*. Theſe, from imperceptible beginnings on the internal ſurface of the inteſtines, unite into larger veſſels laid in the meſentery, and convey the chyle, and what accompanies it, firſt into the conglobate glands of the meſentery, and from thence to the *receptaculum chyli*, as it is called. From this the chyle paſſes by the thoracic duct into the left ſubclavian vein. In one or other part of this courſe of the chyle, the veſſels carrying it are joined by lymphatics, returning the lymph from almoſt every part of the body.

CCXXI.

The matters contained in the inteſtinal canal, not taken into the lacteals, are moved onwards in the courſe of the inteſtines, becoming by degrees of a thicker conſiſtence, eſpecially in the colon, where their motion is conſiderably retarded; but, at length, they are moved onwards to the extremity of the rectum, where their weight, bulk, and acrimony excite motions which throw them entirely out of the body.

CCXXII.

This is the courſe of the alimentary matters, ſo far as they can be conſidered as any ways in a ſeparate ſtate. Of the motions of the ſeveral organs concerned in this courſe, we paſs over thoſe of manducation, deglutition, or others depending on the action of muſcles, the functions of which are readily underſtood from a knowledge of their ſituation; and we are here to conſider only the motions of the alimentary canal itſelf.

CCXXIII.

The motions in the œſophagus depend upon the action of its muſcular fibres, which are chiefly thoſe forming a chain and cirlarly ſurrounding it. This tube, by the morſel of food puſhed into it by the action of deglutition, is neceſſarily dilated, and its circular fibres are thereby excited to a contraction. But as theſe fibres are ſucceſſively dilated, ſo are they alſo contracted, and puſh on their contents through the ſeveral portions of the tube, alternately and ſucceſſively dilated and contracted, giving the appearance of a vermicular motion, and what is commonly called periſtaltic. This motion may be propagated either upwards or downwards; and the direction of it is in the one or the other way, as the motion happens to begin at the upper or lower extremity.

CCXXIV.

The motion of the ſtomach is not ſo ſimple. Its muſcular fibres are in like manner irritable by dilatation, and its circular fibres muſt therefore be in ſome meaſure ſubjected to a ſucceſſive dilatation and contraction. But, though the direction of ſuch motions is from the left to the right, this does not immediately puſh the contents of the ſtomach into the inteſtines. It ſeems to be the purpoſe of the œconomy, to detain the aliment for ſome time in the ſtomach; and therefore, any conſiderable dilatation of the circular fibres, eſpecially that which occurs in a full ſtomach, ſeems to have the effect of exciting the longitudinal fibres to a contraction, which draws the two orifices of the ſtomach nearer to one another. By this the pylorus is raiſed up and rendered leſs eaſily paſſable; and probably, at the ſame time, the peculiar band of circular fibres which ſurround the pylorus, are more firmly contracted, and render it leſs pervious. Vide CXLIV. From hence it is, that the direction of the periſtaltic motion of the ſtomach is ſometimes from the left to the right, and ſometimes alſo the contrary way. It is, however, moſt conſtantly in the firſt manner; becauſe it is commonly begun from the œſophagus, and becauſe, when it is inverted, the reſiſtances on the left from the blind ſac of the ſtomach, from the higher ſituation of the cardia, and from the conſtriction of this by the diaphragm in inſpiration, are commonly more conſiderable than the reſiſtance at the pylorus. The contents of the ſtomach, therefore, are at length puſhed through the pylorus; in the firſt place, the more fluid contents, as theſe occupy the antrum pylori, while the more ſolid, having their air looſened by fermentation, are rendered ſpecifically lighter, and float nearer the upper orifice. But at length, as the ſtomach is in any meaſure emptied, the pylorus is leſs raiſed, is more relaxed, and allows matter to paſs more eaſily; and, at the ſame time, the empty ſtomach contracted more, is eſpecially towards the right extremity contracted to ſuch a degree, as to embrace the ſmalleſt ſolid matters, now fallen down into it, and to puſh them through the pylorus.

This is an idea of the ordinary motions of the ſtomach; but they are, upon ſome occaſions, ſubject to other modifications, as in eructation, rumination, and vomiting, which, however, as morbid, we reſerve to be conſidered in the pathology.

CCXXV.

The motions of the inteſtines will be

readily underſtood, from what has been ſaid of thoſe of the œſophagus. Any portion of the inteſtinal canal being dilated, will in conſequence be contracted, and will urge on its contents in the ſame direction in which the motion was begun. But as the force here is gentle; and as, in the long courſe of the canal, there occur many flexures, different poſitions, and occaſional irritations; it is obvious, that reſiſtances and ſtronger contractions may frequently occur here, to change the direction of the motion: accordingly we find it frequently changed, and directed from below upwards, in ſo far that the contents of the inteſtines frequently paſs into the ſtomach. But the motions of the inteſtines are, however, moſt conſtantly directed from above downwards, both becauſe they are commonly begun from the ſtomach, and becauſe, when inverſions do occur, there is commonly ſtill ſo much reſiſtance at the pylorus, and more eſpecially at the valve of the colon, as to turn the direction again into its proper courſe. In the colon, from its poſition, ſtructure, and the conſiſtence of its contents, the progreſs of theſe is more ſlow and difficult; and it is therefore here aſſiſted by the longitudinal fibres peculiarly diſpoſed, ſo as by their contraction to contribute more to the dilatation of every ſucceeding portion of the inteſtine.

CCXXVI.

The chyle is taken into the lacteals, and moved onwards in theſe in the ſame manner (CLXVII.) as the lymph is in the ſeveral lymphatics in other parts of the body, to which the lacteals are in ſtructure and ſituation exactly ſimilar.

CCXX II.

The courſe of the alimentary matters, and the motions by which they are carried on, being now explained, we return to conſider the ſeveral changes which the aliment undergoes in this courſe.

CCXXVIII.

In the mouth, if the aliment taken in be of a ſolid conſiſtence, it is here, as we have ſaid, ſubjected to a triture; and if our food is of a ſoft and moiſt kind, we are inſtinctively directed to take in along with it ſome dry matter, as bread, that the whole may be ſubjected more certainly to a complete manducation. By this our aliment is not only more minutely broken down, but is alſo intimately mixed, with the liquids at the ſame time taken in, with the ſaliva and other fluids of the mouth, and with a quantity of air intangled by theſe viſcid fluids.

CCXXIX.

In this divided and moiſtened ſtate, the aliment is taken down into the ſtomach, where it is farther diſſolved, the vegetable matter of it begins to be changed to the nature of animal, and the oily parts of the whole begin to be united with the watery. But theſe changes by ſolution, aſſimilation, and mixture, require to be ſeparately conſidered.

CCXXX.

The ſolution here, as in other caſes, may be aſſiſted by the mechanical diviſion of the ſolid matter, by the agitation of the diſſolving maſs, and by the application of heat,

heat; and, with theſe aſſiſtances, the ſolution muſt be performed by the application of a proper menſtruum.

CCXXXI.

The diviſion of the ſolid is ſometimes aſſiſted by a previous cookery, and commonly by the manducation we have mentioned; but the human ſtomach does not ſeem by any mechanical powers to contribute to this. It gives only a moderate agitation, which, in any caſe, contributes little to mechanical diviſion.

CCXXXII.

The degree of heat applied here, being that of the common temperature of the human body, may aſſiſt the ſolution; but it is of no conſiderable power, and no aſſiſtance is got from any cloſeneſs of the veſſel which occurs here. Upon the whole, the aſſiſtances applied here are not conſiderable, and the ſpeedy ſolution that takes place muſt be chiefly owing to the power of the menſtruum.

CCXXXIII.

The menſtruum that appears here, is a compound of the liquid matters taken in, of the ſaliva, and of the gaſtric liquors: but in all, or any of theſe, we do not readily perceive any conſiderable ſolvent power; nor, by any artifice, in employing theſe out of the body, can we imitate the ſolutions performed in the ſtomach.

CCXXXIV.

However, from what happens in the ſtomachs of certain animals, there is ground to preſume, that indeed in every one there is a peculiar ſolvent. But whether this be a menſtruum dividing the ſolid into integrant parts, and thereby reducing it to a fluid ſtate, or if the ſolvent here be a peculiar fermentative power, reſolving matters more or leſs into conſtituent parts, is not clearly perceived.

CCXXXV.

The latter is the moſt probable, as the circumſtances of fermentation very conſtantly appear; and as the deviations which at any time appear in the courſe of digeſtion, appear always to be an exceſs of fermentation, either aceſcent or putrefactive.

CCXXXVI.

The buſineſs ſeems to us to proceed in this manner. The fluids of the ſtomach have the power of ſuddenly and powerfully looſening the fixed air of the alimentary matters, which is the firſt ſtep towards putrefaction, and that which moſt effectually breaks down the texture, and perhaps the mixture of bodies. But we now know, that putreſcent bodies are very powerful in exciting an aceſcent fermentation in vegetable ſubſtances, which the human ſtomach is hardly ever without; and that this aceſcency therefore, in the next place, very conſtantly ſucceeds, and an acid is produced in the ſtomach. This acidity makes the effects of the putrefaction diſappear; and the acidity in its turn diſappears alſo, probably by its being abſorbed by, or united with, the putreſcent and oily matters here preſent; and it is in this manner that we ſuppoſe that the animal fluid is produced, and daily renewed by the combination of a freſh portion of acid with putreſcent fluids previouſly exiſting in the body. The daily production of acid in the human ſtomach, and its readily diſappearing again, without ſhowing any morbid effects, renders our doctrine ſufficiently probable.

CCXXXVII.

This is the aſſimilation of vegetables that I ſuppoſe to take place, and is begun in the ſtomach, but is not completed there: for we obſerve, that the long retention of the alimentary matters in the ſtomach, whether from the inſolubility of the matter, or from an obſtruction of the pylorus, produces a greater degree of acidity; and, in general, the acidity which commonly prevails in the ſtomach does not diſappear but in the after courſe of the aliment.

CCXXXVIII.

It is eſpecially the bile, added to the matters which have paſſed from the ſtomach into the duodenum, that is fitted to cover the acidity which appeared in the ſtomach. It is probable alſo, that the pancreatic and inteſtinal liquors contribute to the ſame effect; and it is perhaps for the ſame purpoſe, that the lymph is conſtantly added to the chyle in its courſe. But, after all, we muſt reſt in the general idea, and own that we do not know exactly how this matter proceeds, nor what the ſeveral fluids, added to the aliment in the different parts of its courſe, truly contribute to the changes of it.

CCXXXIX.

It is probable, however, that, by the

mixture mentioned, the peculiar fluid which we name the *chyle* is produced; for, though it is certain that a variety of fluid matters may enter the lacteals and accompany the chyle there, it is ſtill probable, that there is a peculiar fluid produced by the actions of the ſtomach and inteſtines, and ſuch as becomes the principal ingredient in the animal fluids afterwards formed, that is ſtrictly intitled to that apellation. This chyle does not appear in the ſtomach; but firſt in the duodenum, and more copiouſly ſtill in the jejunum and firſt part of the ileum. It appears indeed in the whole of the ileum, cœcum, and colon, but in the laſt leſs copiouſly: all which ſhows, that a particular mixture is neceſſary to it; and at the ſame time that it is not made at once, but ſucceſſively in the courſe of the inteſtines.

CCXL.

It remains to ſpeak of the mixture of the oily with the watery parts of the aliment. This we cannot well explain; but it is of conſequence to obſerve here, that ſuch a mixture is actually made. It is evident that a large quantity of oil in a ſeparate ſtate is taken in as a part of our aliment, but at the ſame time no oil commonly appears in a ſeparate ſtate in the maſs of blood; it muſt therefore be united with the other parts of the maſs in the way of mixture. Hitherto the phyſiologiſts have hardly mentioned any other means for this union of oil but the application of viſcid fluids; but theſe can occaſion only a diffuſion, and ſome means of mixture muſt neceſſarily be ſuppoſed. What theſe however are, we do not certainly know. They do not produce their effect in the firſt paſſages; for in the chyle, till it enters the ſubclavian vein, the oil appears to be only in a diffuſed ſtate, and probably the perfect mixture is only made in the paſſage through the lungs.

CCXLI.

It may be proper here to take notice of another matter which conſtantly enters into the mixture of animal fluids. This is air, which, by different means, can be extracted in conſiderable quantity from every kind of animal matter. What is properly the origin of this, when and where it is inſinuated into the animal fluids, and by what means it is either fixed in theſe or looſened from them, are all queſtions not yet reſolved; but perhaps neceſſary to be reſolved, before we can ſpeak with any confidence of the changes which the animal fluids undergo in different parts of the ſyſtem. We can obſerve, in the mean time, that a quantity of air is always preſent in the chyle in a very looſe ſtate; that it becomes more fixed in the maſs of blood after this has paſſed through the lungs; and that again, in the different ſecreted fluids, the air appears to be in ſome of them ſtill fixed, and in others much more looſe; and it is probable, that all this has a particular relation to the production and properties of the different fluids of animals.

CCXLII.

We have now followed the courſe of the aliments, ſo far as we can conſider them as any ways in a ſeparate ſtate; but we do not perceive, that, in any part of this courſe, the proper animal fluids are entirely formed: And it is very juſtly ſuppoſed, that the proper mixture or aſſimilation is not finiſhed till the chyle, mixed with the maſs of blood, has undergone the action of the lungs, through the veſſels of which it muſt almoſt immediately paſs, after entering the ſubclavian vein, and ſeemingly before it is applied to any of the purpoſes of the animal œconomy.

CCXLIII.

What change the fluids undergo in paſſing through the lungs, or by what means the ſuppoſed changes are produced, after all that has been ſaid, ſeems ſtill to be very little known.

The mechanical powers of preſſure, commonly ſpoken of, do not in fact take place, nor are their ſuppoſed effects any ways conſiſtent with ſound philoſophy; and, on the other hand, it is very probable, that the changes produced are the effects either of chemical ſeparation or mixture.

What has been ſuppoſed to be performed in this way by an abſorption of air, or of a particular matter from it, is very uncertain in fact, and has led to a ſtill more uncertain reaſoning.

It is now certain, that a quantity of mephitic air, and perhaps ſome other matters are conſtantly exhaling from the lungs of living animals, and are carried off by the atmoſpherical air alternately entering and iſſuing from the lungs. This is a pretty certain evidence that ſome change of mixture is going on in the fluids paſſing through the lungs; but from what particular portion of the fluids the mephitic air proceeds, or what is the effect of its ſeparation, we know not: And indeed, as we have ſaid before, what are the effects of the action of the lungs upon the ſtate of the fluids, we are very uncertain. Upon the whole, we ſtill know but little of the production, or formation, of the animal fluids; and therefore from the conſideration of their formation, we have learned little of their nature; but we muſt now try to diſcover what we can of it, by examining theſe fluids as they are found already formed in the blood-veſſels.

SECT. IV.

CHAP. II.

OF ANIMAL BLOOD.

CCXLIV.

THE red fluid paſſing from the lungs to the left ventricle of the heart, and thence by the aorta and its branches to every part of the body, may be conſidered as a maſs containing, either formally or materially, every part of the animal fluids;

and may therefore be called the *common maſs of blood.* This term, however, muſt be ſtrictly confined to the circulating fluids while they retain their red colour; for when they loſe this, it is always in conſequence of ſome ſeparation of parts. The ſame red fluid, indeed, as it is found in the veins, has alſo ſuffered ſome ſeparation of parts; but as the blood in the veins is never entirely deprived of the whole of any matter that was preſent in the arteries, ſo we think the venous blood may ſtill be conſidered as a part of the common maſs.

CCXLV.

This maſs of blood we find to be an heterogeneous aggregate; and it will be proper to inquire into the ſeveral parts of this before we employ any chemical trials for diſcovering the mixture of the whole, or of its parts.

CCXLVI.

We diſcover the parts of this aggregate chiefly by the ſpontaneous ſeparation of them, which takes place upon their being drawn out of the veſſels of a living animal.

CCXLVII.

The ſeparation commonly proceeds in this manner. Immediately after the blood is drawn out, it exhales a ſenſible vapour, and, after ſome time, it is found by that exhalation to have loſt a part of its weight, more or leſs, according to the degree of heat it is expoſed to, according to the extent of ſurface by which it is expoſed to the air, and probably alſo according to different conditions of the blood itſelf. The matter thus exhaling may be called the *halitus* or vapour of the blood.

CCXLVIII.

Soon after the blood has been drawn out of the veſſels, it loſes its fluidity, and the whole of it concretes into one ſoft gelatinous maſs: but after ſome time, there oozes out from this maſs a thin fluid; and as the ſeparation of this proceeds, the maſs contracts into a ſmaller bulk, and, in proportion, becomes more denſe.

CXLIX.

This is the ſeparation which almoſt always takes place, and has at all times been obſerved by phyſicians. The fluid part is called *ſerum;* and the thicker conſiſtent part has been called *cruor*, but more properly the *craſſamentum*.

CCL.

Both parts ſeeem homogeneous and ſimple, but are not. For, if the craſſamentum taken from the ſerum be laid upon a linen cloth, and water is poured upon it, the water waſhes off a red coloured part, and carries it through the pores of the cloth; and there remains a whitiſh, conſiſtent, but ſoft and tough maſs, not to be further diminiſhed or ſeparated into parts by any ablution.

A like experiment ſhows always a like matter preſent in the maſs of blood; and upon ſeveral occaſions, both while the blood remains within the veſſels, whether of the living or dead body, and when it is drawn out of the veſſels of the living, this matter ſpontaneouſly ſeparates from the other parts of the blood. It is therefore a part conſtantly preſent in the blood. It is what Gaubius, after Malpighi, calls the *fibra ſanguinis*. Mr Senac names it the *coagulable lymph*; and we ſhall ſpeak of it under the title of the *gluten of the blood*. When it appears upon the ſurface of the blood drawn out of the veſſels of living animals, it is called the *inflammatory cruſt*.

CCLI.

When the blood is viewed with a microſcope, whether as moving in the veſſels of a living animal, or when out of the veſſels remaining ſtill fluid, there are certain parts of it which appear of a round figure, and alſo of a red colour, while the reſt is almoſt colourleſs. The parts thus diſtinguiſhable by their figure are called the red globules; and it appears that the red colour of the whole maſs depends upon the preſence of theſe only. It is chiefly theſe parts which are waſhed off from the craſſamentum in the experiment abovementioned; and we now conclude, that, beſides the globules, the gluten, and a portion of ſerum that happens to be entangled in the pores of the concreting maſs, there is no other matter evident in the craſſamentum.

CLII.

The ſerum is a tranſparent fluid of very little colour, and ſeemingly ſimple; but if it be expoſed to a heat of 156 degrees of Fahrenheit's thermometer, it concretes into a firm and almoſt tranſparent gelly; and, if this be cut into minute pieces, there exudes from it a thin colourleſs fluid of a ſaline taſte. In proportion as this fluid is more carefully ſeparated, the coagulated part becomes inſipid, and in all its properties reſembles the gluten ſeparated from the craſſamentum. From hence we are ready to conclude, that the ſerum, as obtained by ſpontaneous ſeparation, conſiſts of a portion of gluten diſſolved in a ſaline fluid, which we name the SEROSITY.

CCLIII.

From the whole that has been ſaid from CCXLIV. to CCLII. it appears that there are three diſtinct portions and kinds of matter in the common maſs of blood; that is, red globules, gluten, and ſeroſity. What other matters may alſo be there, we ſhall conſider afterwards; but, in the mean time, ſhall ſay a little more of each of the parts we have already mentioned.

CCLIV.

The red globules have been conſidered as an oily matter, and from thence their diſtinct and globular appearance has been accounted for; but there is no direct proof of their oily nature, and their ready union with and diffuſibility in water renders it very improbable. As being microſcopical objects only, they have been repreſented by different perſons very differently. Some have thought them ſpherical bodies, but diviſible into ſix parts, each of which in their ſeparate ſtate were alſo ſpherical; but other perſons have not obſerved them to be thus diviſible. To many obſervers, they have appeared as perfectly ſpherical, while others judge them to be oblate ſpheroids or lenticular. To ſome they have appeared as annular; and, to others, as containing a hollow veſicle. All this, with ſeveral other circumſtances relating to them, very variouſly repreſented, ſhow ſome uncertainty in microſcopical obſervations; and it leaves me, who am not converſant in ſuch obſervations, altogether uncertain with reſpect to the preciſe nature of this part of the blood. The chemical hiſtory of it is equally precarious; and therefore, what has been hitherto ſaid of the production, and changes happening to theſe red globules, we chooſe to leave untouched. We ſhall afterwards ſay ſomething with reſpect to their general uſe in the animal ſyſtem; and now we ſhall attempt to explain the cauſe of ſome changes, which in certain circumſtances appear in the colour of the whole maſs of blood.

CCLV.

We ſuppoſe that the red globules, when viewed ſingly, have very little colour; and that it is only when a certain number of them are laid upon one another, that the colour appears of a bright red: but this alſo hath its limits; ſo that, when the number of globules laid on one another is conſiderable, the colour becomes of a darker red. Upon this ſuppoſition, the colour of the maſs of blood will be brighter or darker as the colouring part is more or leſs diffuſed among the other parts of the maſs; and we think this appears to be truly the caſe, from every circumſtance that attends the changes which have been at any time obſerved in the colour of the blood.

CCLVI.

The gluten of the blood, from its reſemblance on the one hand to the *albumen ovi*, and on the other to the matter of the ſolids of animal bodies, we conſider as the principal part of animal fluids, as that which is immediately formed of the aliment taken in, and as that which is employed in increaſing the growth of the ſolids, or in repairing their waſte.

CCLVII.

But it is well known, that the animal fluids in general, and particularly the gluten, is prone to putrefaction; and that, even in the living body, if freſh aliment be not conſtantly taken in, and alſo if certain excretions which carry off putreſcent matter be not conſtantly ſupported, a conſiderable putrefaction certainly takes place. From hence we are led to think, that ſome approach to putrefaction conſtantly takes place, even in the moſt healthy bodies; and that it appears eſpecially in an evolution of ſaline matter; and that this, taken up by the water conſtantly preſent, forms the ſeroſity. We ſuppoſe it is this which affords the vapour of the blood, (CCXLVII.) and that it is the ſeroſity diſſolving a portion of the gluten which forms the ſerum that appears upon ſpontaneous ſeparation (CCXLVII.)

CCLVIII.

The ſaline matters impregnating the ſeroſity, if we may judge from the analyſis of urine, are of various kinds; but particularly, there is preſent an ammoniacal ſalt, now well known under the name of the *eſſential ſalt of urine*, which, if not originally formed, is at leaſt moſt copiouſly evolved in animal fluids.

CCLIX.

Theſe are our conjectures concerning the parts of animal blood; and it remains to ſay in what proportion each of them is preſent in it. This will perhaps be always difficult; and in the mean time we can perceive, that many eſtimates formerly made could not be exact, as the ſeveral parts were not properly known; and, while judging chiefly from the appearances upon ſpontaneous ſeparation, phyſicians were not aware how much theſe are affected by the circumſtances of extravaſation, and by thoſe in which the blood is placed after being drawn out. There are not yet indeed experiments made to aſcertain, with any exactneſs, the proportion of the ſeveral parts mentioned: but it is probable, that the red globules make a ſmall part of the whole; that the gluten, if we conſider both what is in the craſſamentum and in the ſerum, is in much larger proportion; but that the watery portion is the largeſt of all, and at the ſame time that this has always a conſiderable quantity of ſaline matter diſſolved in it.

CCLX.

We would next put the queſtion, By what means the parts of this heterogeneous maſs are kept ſo equably diffuſed among one another, and the fluidity of the whole ſo conſtantly preſerved? This we ſuppoſe to be done chiefly by motion and heat, and by the parts diſpoſed to concrete being kept from the contact of any matters to which they might adhere more firmly than they do to the other parts of the blood. The diffuſed parts we ſuppoſe to be preſent only in thoſe veſſels in which a conſiderable degree of agitation is conſtantly kept up; and we ſuppoſe alſo, that the heat always here preſent, both diminiſhes the cohesion of the gluten, and increaſes the ſolvent power of the ſeroſity. Experiments made with neutral ſalts ſeem to confirm the latter; and it is alſo probable, that the ſame ſolvent power may be increaſed by a quantity of air that is conſtantly intermixed with the maſs of blood while it remains in the veſſels, and is under a conſtant agitation. It is ſuppoſed, that an attention to theſe ſeveral circumſtances will explain moſt of the caſes of ſpontaneous ſeparation that occur either in the living or dead body, within the veſſels or without them; but the detail would be too long for this place.

CCLXI.

We ſhall add here a few words on the uſe of this ſingular compoſition of animal blood which we have been conſidering.

It appears evidently, from many circumſtances of the animal œconomy, that its functions require a ſyſtem of veſſels conſtantly filled, and even diſtended; but as, at the ſame time, theſe veſſels muſt be open by a multitude of their extremities, if all the fluids were ſuch as could paſs by theſe extremities, the ſyſtem could not be kept filled for a few minutes. It is neceſſary, therefore, that the fluids ſhould be partly of ſuch a ſize as that they cannot paſs through the ſmaller veſſels, and partly in a diffuſed ſtate only, which has commonly the ſame effect. Hence it is, that the red globules, under the ordinary impetus of the heart and arteries, are ſtrictly confined to certain veſſels; and it is probable, that, in the like circumſtances, the diffuſed gluten does not go much farther. This ſerves to keep the larger veſſels of the ſyſtem conſtantly filled. But, on the other hand, the ſeroſity being ſufficiently fluid, might be ſuppoſed to run off by the many outlets open to it, and thereby to leave the fluids in the larger veſſels of a conſiſtence unfit to circulate. This, however, ſeems alſo to be obviated by the viſcidity of the groſſer parts of the blood, ſufficient always to entangle ſo much of the more fluid, as may be neceſſary to preſerve the due fluidity of the whole.

CCLXII.

The heat of the human body, ſupported by powers within itſelf, is probably the effect of the motion of the blood, and might have been treated of when we were conſidering that ſubject. But as many perſons ſuppoſe it to depend in ſome meaſure on the nature of the fluids, we have reſerved it for this place; and here perhaps to ſay only, that the queſtion concerning the cauſe of animal heat is not yet ſolved.

CCLXIII.

The opinion of animal-heat's being the

effect of mixture, is to be little regarded; as the matters ſuppoſed to be mixed, the place in which the mixture is made, and the other circumſtances relating to it, are equally hypothetical, and the whole is ill ſupported by any analogy.

CCLXIV.

More ſpeciouſly is animal-heat ſuppoſed to be the effect of putrefaction, towards which there is certainly ſome approach in animal bodies; but the opinion is ſtill very doubtful. For, *firſt*, the effect of any degree of putrefaction in producing heat is not well aſcertained. *Secondly*, It is not ſupported by any analogy, that putrefaction, in the degree to which only it proceeds in living bodies, is capable of producing the heat appearing there. And, *laſtly*, Whatever is the degree to which putrefaction proceeds in living bodies, it does not appear that there is any increaſe of heat correſpondent to the increaſe of putrefaction, and rather the contrary.

CCLXV.

The ſuppoſitions either of mixture, or of putrefaction, as the cauſe of animal-heat, are both of them rejected by this, that the generation of heat in animal bodies is manifeſtly dependent on another cauſe, that is, the motion of the blood. For the power of generating heat in any animal is not perfect till the motion of the blood in it is fully eſtabliſhed; and, when the generating power is eſtabliſhed, we perceive the heat to be increaſed or diminiſhed as various cauſes increaſe or diminiſh the motion of the blood. In dying animals, the heat grows leſs as the motion of the blood grows leſs; and when at death this ceaſes altogether, the heat ceaſes alſo, commonly, at leaſt, as ſoon after death as we can ſuppoſe a body of the ſame bulk to loſe the heat it had acquired.

CCLXVI.

This connection between the heat and motion of the blood ſeems in general to be well proved; and, though it may be difficult to reconcile certain appearances to it, we would ſo far admit of the ſuppoſition, as to inquire, in the next place, into the manner in which the motion of the blood may generate heat.

CCLXVII.

On this ſubject, the moſt common opinion is, that the heat is produced by the attrition of the particles of the blood upon one another, or of theſe on the internal ſurface of the veſſels in which they move.

But we cannot find any analogy to ſupport either the one or the other ſuppoſition.

The attempt made to ſupport the latter ſuppoſition, by endeavouring to ſhow, that upon this the equality of heat in the different parts of the ſame body is well explained, deſerves little regard, as it is founded on doubtful principles and miſtaken facts.

CCLXVIII.

The equality of heat in the different parts of the ſame body ſeems to require the generating power to be very generally diffuſed over the whole; but it does not ſeem to require its being preciſely equal in every part, as the interpoſition of pretty large veſſels in every part of the body, and the ſpeedy communication of the fluids from any one part to every other, will ſufficiently account for the equality of heat, though the generating power ſhould be in ſome meaſure confined to certain parts only.

However, we take no notice of the ſuppoſitions which have been made of the generating powers being confined to certain ſmall portions of the ſyſtem only. Theſe ſuppoſitions give no relief in the general theory, and they are not ſupported by any particular evidence. The breathing animals are the warmeſt; but that they are warmer becauſe they breathe, is not more probable than that they breathe becauſe they are warmer.

CCLXIX.

With reſpect to this theory, which deduces animal-heat from the motion of the blood, we muſt own, that it is attended with ſeveral difficulties. It will be difficult to ſhow, in ſo many animals of different age, ſize, and temperament, in which the degree of heat is nearly the ſame, that the motion of the blood, in all its circumſtances, is alſo exactly the ſame; or to ſhow, in the different animals in which the degree of heat is conſiderably different, that the motion of the blood in each is correſpondent to the difference of heat. May it not be ſuppoſed, that there is ſome circumſtance in the vital principle of animals which is in common to thoſe of the ſame claſs, and of like œconomy, and which determines the effect of motion upon the vital principle to be the ſame, though the motion acting upon it may be in different circumſtances?

CCLXX.

In all we have hitherto ſaid of animal fluids, we have conſidered the common maſs of blood as conſiſting of three parts or three kinds of matter only; but many more have been ſuppoſed to be preſent in it, and we ſhall inquire upon what ground.

It is common to ſuppoſe, that the aliment or the chyle formed of it is not perfectly aſſimilated in paſſing once only thro' the lungs; but that, for ſome time after ſuch paſſage, it continues to circulate with the blood under the ſame form and of the ſame qualities which it had when it firſt entered the ſubclavian, and particularly in this ſtate to furniſh the milk which is ſecreted in the breaſts of females. There is, however, no proper evidence of the chyle's ever appearing in the blood-veſſels, and the appearances of it alleged can be otherwiſe accounted for. The arguments for the ſame opinion, which are drawn from the conſideration of the ſecretion of milk, are embarraſſed with many difficulties.

CCLXXI.

It is probable, that the animal fluid (CCLV. CCLVI.) is in a conſtant progreſs, and hardly for a moment ſtationary, or therefore uniformly the ſame over the whole of the common maſs. Some part of it is that which was laſt formed, and therefore the neareſt to the vegetable matter from which chiefly it was produced; while another part of it is that which has remained longeſt in the body, and is therefore the neareſt to putrefaction. Between theſe two there may be ſeveral intermediate ſtates, which, however, like the neareſt ſhades of the ſame colour, are not diſtinguiſhable by our ſenſes or experiments.

CCLXXII.

Beſides the difference of matter ariſing from the progreſs of the animal fluid, there have been other matters ſuppoſed preſent in the common maſs, and as commonly conſtituent parts of it. Such are a mucous matter, like to the mucous matter of vegetables; and a gelatinous matter, like to that which is extracted by decoction from the ſolid parts of animals. But there is no evidence of either being formally preſent in the maſs of blood, and the ſuppoſition is founded on miſtaken facts and falſe reaſonings.

CCLXXIII.

But it is proper to be obſerved here, that many extraneous matters may, by different ways, be introduced into the blood-veſſels; and that many of the ſecreted fluids, ſometimes very different from any thing that exiſted before in the maſs of blood, may, by abſorption or regurgitation, be again taken into the blood-veſſels: But, with regard to all of theſe, whether extraneous matters, or thoſe produced in the body itſelf, it is probable that hardly any of them enter into the mixture of the animal fluid, and that they are only diffuſed in the ſeroſity till they can be again thrown out of the blood-veſſels by the readieſt outlets. The oil of the adipoſe membrane is frequently, and perhaps neceſſarily reabſorbed, and ſeems to be, beſides the lymph, the only reabſorbed matter which enters again into the mixture of the animal fluid.

SECT. IV.

CHAP. III.

Of Secretion.

CCLXXV.

AFTER thus conſidering the parts of the maſs contained in the red veſſels, we muſt next conſider the ſeveral fluids which appear in the other parts of the of the body.

CCLXXVI.

All of theſe we ſuppoſe to be derived from the common maſs, as they appear in veſſels continuous with thoſe of the common maſs, and as their appearance ceaſes when the communication of the veſſels containing them, with the ſanguiferous veſſels, is any how interrupted.

CCLXXVII.

The fluids thus derived from the common maſs ſeem to be produced in conſequence of a certain ſtructure, with perhaps ſome other condition in the extreme veſſels through which the fluids paſs; and a part having ſuch a ſtructure, is called a *gland* or *ſecretory organ*, the function of which, from the moſt obvious notion of the manner of it, is called *ſecretion.*

CCLXXVIII.

The ſtructure of the organ, and the manner of its function, ſeem to me for the moſt part unknown; at leaſt, what we know or ſuppoſe with regard to the ſtructure hardly in any caſe applies to the explanation of the function.

CCLXXIX.

If it any how appeared that the ſeveral ſecreted fluids were all of them previouſly exiſtent in the ſame forms in the maſs of blood, it would not perhaps be difficult to explain what might be ſtrictly called a ſecretion. But ſuch previous exiſtence does not appear; for, except the matter of exhalation into the ſeveral cavities of the body, and the matter of urine and of perſpiration, we find no proper evidence of any other ſecreted fluids preſent in the maſs of blood. We cannot find there, either milk, mucus, or oil, and much leſs the appearance of many other fluids which are only found after they have paſſed through certain organs.

CCLXXX.

This being the caſe, the conſiderations of the phyſiologiſts with regard to the velocity of the blood, and other circumſtances favouring the ſeparation of the parts of a fluid which are only diffuſed among one another, deſerve no attention. The effects of different apertures may go ſome length; but we can perceive their particular application only in the few caſes of a ſimple ſeparation. In moſt others, there appears to be a change of mixture; but we perceive neither the preciſe changes that are made, nor the the cauſe of them.

CCLXXXI.

Till we can diſcover theſe more clearly, we may in the mean time obſerve, that the action of the veſſels of the ſecretory organ has a conſiderable ſhare in determining both the quantity and quality of the ſecreted fluid, and that both very often are very little affected by the general ſtate of the circulation, or by the different conditions of the maſs of blood.

CLXXXII.

It would ſeem that no other ſecretion but thoſe of perſpiration and ſweat are manifeſtly increaſed by the increaſed action of the heart and arteries (CLXXXI.); and that moſt of the other ſecretions are increaſed only by ſtimulants applied to their organs. Theſe ſtimulants may be either ſuch as are immediately applied externally or internally to the excretory, or perhaps to the ſecretory veſſels; or they may be ſuch as are applied to the ſenſorium, or to diſtant parts of the nervous ſyſtem, which by the laws of the animal œconomy have a connection with the organs of ſecretion. Theſe ſtimulants, at the ſame time that they act in either of theſe ways on the ſecretory organs, for the moſt part have no ſenſible effect on the general ſtate of the circulation of the blood.

CCLXXXIII.

With reſpect to the influence of the condition of the common maſs of blood upon the ſeveral ſecretions, we preſume that the ſtate of the quantity of the fluids in general will affect the quantity of every ſecretion; but the effects of the quantity of the whole maſs are very remarkable only, with reſpect to the ſecretions of perſpiration, urine, and milk.

The qualities of the common maſs may alſo be preſumed to affect the ſeveral ſecretions: but the effect of theſe qualities appears moſt remarkable in the ſame ſecretions of perſpiration, urine, and milk; and, even in theſe, the effect ſeems to depend upon the proportion of water more than upon that of any other matter in the common maſs. With reſpect to the other ſecretions, we cannot perceive that any of them are increaſed by a particular matter preſent in the maſs of blood, except it be ſuch a matter as ſtimulates the ſecretory organ.

CCLXXXIV.

The ſeveral ſecretions are frequently obſerved to affect each other mutually, ſo that the increaſe of one diminiſhes another, and *vice verſa*. This ſeems to depend either upon a change of determination in the courſe of the blood (CLXXVIII.), or upon a change in the ſtate of fluidity of the common maſs, or perhaps upon a connection eſtabliſhed between the different organs of ſecretion as parts of the nervous ſyſtem; and, except it be in the caſe of perſpiration and urine, we cannot perceive that the effect of the ſtate of one ſecretion upon that of another depends upon an increaſe or diminution of any particular matter in the maſs of blood.

CCLXXXV.

After mentioning theſe generalities with reſpect to ſecretion, we ſhould, perhaps, proceed in the next place to conſider the application of them to the particular ſecretions, and alſo to conſider more particularly the ſeveral ſecreted fluids: but we omit both theſe ſubjects, as we preſume the former will be obvious from what is already ſaid; and with reſpect to the latter, we have not yet a ſufficient number of experiments to proceed any length in it.

SECT. IV.

CHAP. IV.

OF NUTRITION.

CCLXXXVI.

UNDER this title we might conſider how the matter both of the fluids and ſolids of the body is ſupplied: but, after what we have formerly ſaid of the taking in and aſſimilation of the aliment, we have nothing now to add with reſpect to the fluids; and we therefore confine ourſelves here to conſider in what manner the ſolid parts obtain their increaſe of matter and growth, or have their occaſional waſte repaired.

CCLXXXVII.

There is no doubt that the ſolids are formed of the fluid prepared from the aliment in the manner we have ſaid; but it is required now to ſay what portion of the fluids is employed in nouriſhing the ſolids, by what channels the nouriſhment is conveyed to them, and, being applied there, how from fluid it becomes ſolid.

CCLXXXVIII.

With regard to the firſt queſtion, we have no doubt in aſſerting, that in oviparous

parous animals, it is the albumen ovi that is employed in nouriſhing the chick; and we preſume that it is an analogous fluid which is employed in nouriſhing the bird during the whole time of its growth. We think the analogy may be ſafely applied with reſpect to all animals, the ſolid matter of which is of the ſame kind with that of the oviparous.

CCLXXXIX.

This analogous fluid we take to be the gluten of the blood, properly diluted and freed from any adhering ſaline matter.

CCXC.

To determine in what manner this nutritious fluid is applied to the nouriſhment of the ſolids, it is neceſſary to conſider what are the ſimple fundamental ſolids, of which all the others are formed.

CCXCI.

It ſeems to be the opinion of the greater part of modern anatomiſts, that the ſolid parts conſiſt entirely of a cellular texture, of various denſity in the different parts; and indeed, the ſtructure of the greateſt part of the ſolids is evidently of this kind. But at the ſame time, it is alſo true, that a fibrous ſtructure is to be obſerved almoſt every where in the body. It appears in the medullary ſubſtance of the brain and nerves, in the muſcles and tendons, in the arteries, in the excretories of the glands, in the lymphatic veſſels, in the alimentary canal, in the uterus and bladder of urine, in the ligaments, in moſt membranes; and it is to be ſeen in thoſe membranes which are afterwards changed into bones, eſpecially whilſt this change is going on.

CCXCII.

From this view of the univerſality of a fibrous ſtructure in animal bodies we are diſpoſed to believe, that theſe fibres are the fundamental part of animal ſolids; that they are the primordial ſtaminal part of animal bodies; and that the cellular texture is, for the moſt part, an accretion formed upon theſe fibres.

The conſideration of the ſtructure and growth of vegetables ſeems to illuſtrate and confirm this opinion.

CCXCIII.

At the ſame time, from the fibrous parts (CCXCI.) being evidently, in moſt inſtances, parts of the nervous ſyſtem, and from the gradual formation of the fœtus in which the nervous ſyſtem is firſt formed, we think it probable, that the

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CCXCIV.

This ſuppoſes alſo, what is otherwiſe probable, that the cortical part of the brain, or common origin of the nerves, is a ſecretory organ, in which the gluten of the blood being freed from all ſaline matter before adhering to it, becomes fit for the nouriſhment of the ſolids, and being poured in a ſufficiently diluted ſtate upon the organ of the nerves, it is filtrated along the fibres of theſe, and is thus conveyed to every ſtaminal fibre of the ſyſtem. We ſuppoſe, at the ſame time, that the medullary, or what may be called the ſolid matter of the nerves, is in the living body conſtantly accompanied with a ſubtle elaſtic fluid, which fits them for being the organs of ſenſe and motion, and which probably is alſo the means by which the nutritious fluid is carried on in the ſubſtance of the nerves, from their origin to their extremities.

In what manner the nutritious fluid, thus carried to the ſeveral parts, is there applied, ſo as to increaſe the length of the nervous fibre itſelf, or to form a cellular texture upon its ſurface, and in what manner from fluid it becomes ſolid, we cannot explain; nor can theſe particulars be explained upon any other ſuppoſition that has been formed with reſpect to nutrition.

CCXCV.

It is probable, that, for a certain time, at its firſt beginning, the growth of animal bodies proceeds in the ſame manner as that of vegetables: but it is evident, that, at a certain period, in the growth of animals, a different œconomy takes place; and that, afterwards, the growth ſeems to depend upon an extenſion of the arteries in length and wideneſs by the blood propelled into them by the powers CLVI. CLIX. It may be ſuppoſed, that this extenſion of the arteries is applied to every fibre of the body, and that by the extenſion of theſe it gives an opportunity to the application and accretion of nutritious matter; to the growth therefore of the fibre itſelf, and to the growth of cellular texture on its ſurface. Perhaps the ſame extenſion of the arterial ſyſtem gives occaſion to the ſecretion of fluids, which poured into the cellular texture already formed, according to the diſpoſition of theſe fluids to concrete more or leſs firmly, gives the different degrees of denſity and hardneſs which appears in different parts of the body.

CCXCVI.

By this extenſion of the arterial ſyſtem, the ſeveral parts of the body are gradually evolved, ſome of them ſooner, others later, as by the conſtitution of the original ſtamina, or after occurrences, they are ſeverally put into the conditions CLXXVII. CLXXVIII. by which they are more or leſs expoſed to the impetus of the blood, and fitted to receive a greater quantity of it. But as the parts by theſe cauſes firſt evolved will increaſe the moſt in the denſity of their ſolid parts, they will therefore more and more reſiſt their further growth; and by the ſame reſiſtance, will determine the blood with more force, and in greater quantity, into the parts not then ſo far evolved. Hence the whole ſyſtem will be at length evolved, and every part of the ſolids will, in reſpect of denſity and reſiſtance, be in balance with every other, and with the forces to which they are ſeverally expoſed.

CCXCVII.

The extenſion of the arteries (CCXCV.) depends upon the reſiſtances which occur to the free tranſmiſſion of the blood through them, as in CLXX.; and further, from a reſiſtance in the veins. For, as a conſiderable portion of the blood (by CCLXI.) does not commonly paſs into the ſmaller branches of the arteries, but muſt paſs very entirely into the veins; ſo theſe, by their capacity conſtantly diminiſhing as they approach nearer to the heart, and by their coats being of a denſity and firmneſs ſufficient to prevent further dilatation, conſiderably reſiſt the free paſſage of the blood from the arteries into them.

CCXCVIII.

While theſe reſiſtances continue, the arteries, and with them almoſt every fibre of the body, muſt be extended at every ſyſtole of the heart; and with this extenſion, the growth of every part will proceed: but, as every part, by its receiving an addition of ſolid matter, becomes more denſe and rigid; ſo it is leſs eaſily extended, and perhaps leſs readily receives an accretion of new matter, than before. Hence it is, that the more the body grows, it admits of any additional growth more ſlowly; and unleſs the extending powers increaſe in the ſame proportion with the increaſing denſity of the ſolids, there muſt be a period at which theſe two powers will balance each other, and the growth will proceed no farther. But, as it is evident, that the bulk and weight of the heart, and probably therefore its force, does not increaſe with the increaſing bulk of the body, and that the action of the heart is the principal extending power in the ſyſtem; it is alſo plain, that the extending power does not increaſe in the ſame proportion with the increaſing denſity of the ſolids; and therefore, that theſe two powers will, at a certain period, come to balance each other.

CCXCIX.

But not only is the force of the heart thus conſtantly diminiſhing, with reſpect to the reſiſtance of the arteries; but the force of the heart, though it were ſtill ſubſiſting, has, from other cauſes, leſs effect in extending the arteries. The blood is more confined to the arteries, and extends them further in proportion to the reſiſtance in the veins, as in CCXCVII.; and this reſiſtance in the veins, and the extenſion of the arteries depending upon it, will be more or leſs, according to the reſpective denſity of theſe two ſets of veſſels. But it appears from the experiments of Sir Clifton Wintringham, that the denſity and firmneſs of the veins with reſpect to their correſpondent arteries, is much greater in young animals than in old; and thence it appears, that during the growth of animals, the arteries are acquiring an increaſe of denſity in a greater proportion than the veins are at the ſame time; and therefore, that the reſiſtance in the veins with reſpect to the arteries, muſt be conſtantly diminiſhing; that the veins will therefore receive a greater proportion of blood; that in the ſame proportion the arteries will be leſs extended; and, *laſtly*, that the diminiſhed reſiſtance in the veins, concurring with the diminiſhed force of the heart, will the ſooner bring the increaſing rigidity of the arteries, and therefore of every fibre of the body, to be in balance with the extending powers; at leaſt, ſo far as to prevent their producing any further growth.

CCC.

This account of the change of the reſiſtances in the arteries and veins, with reſpect to one another, is agreeable to phenomena, which ſhow that the arteries are larger, and contain more blood in proportion to the veins in young animals, than in old; that arterial hemorrhagies, occur moſt frequently in young perſons; and that congeſtions in the veins, with hemorrhagies, or hydropic effuſions depending upon them, occur moſt frequently in old age.

CCCI.

It is probable, that the reſiſtance both of arteries and veins goes on increaſing, while the force of the heart is not increaſing at the ſame time: but it appears alſo, that, from the diminiſhed force of the heart, and the compreſſion which the ſmaller veſſels are conſtantly expoſed to from the diſtention of the larger, the action of the muſcles and other cauſes, the number of ſmall veſſels, and therefore the capacity of the whole ſyſtem, is conſtantly diminiſhing ſo much, that the heart may ſtill for ſome time be ſufficient for the circulation of the blood. But, while the reſiſtances in the veſſels are conſtantly increaſing, the irritability of the moving fibres, and the energy of the brain, are at the ſame time conſtantly diminiſhing; and therefore the power of the heart muſt at length become unequal to its taſk, the circulation muſt ceaſe, and death enſue.

CCCII.

The unavoidable death of old perſons is thus in part accounted for; but it is, however, ſtill probable, that the ſame event proceeds chiefly from the decay and total extinction of the excitement or vital power (CXXXVI.) of the nervous ſyſtem, and that from cauſes very independent of the circulation of the blood, and ariſing in the nervous ſyſtem itſelf in conſequence of the progreſs of life. This ſeems to be proved by the decay of ſenſe, memory, intellect, and irritability, which conſtantly takes place, as life advances beyond a certain period.

FINIS.